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IN ALL THEIR DEPARTMENTS.

THE THEORY AND PRACTICE OF BLASTING BY GALVANISM.

(With a Plate.)

In this article we are desirous of explaining the principles and application of this important discovery, in so clear a manner as to render it completely intelligible to the practical man, however deficient may be his attainments in science.

It is quite certain, that whatever value belongs to any improvement of this kind, its application will be very limited, and the whole process will be looked upon with suspicion, jealousy, and perhaps with ridicule, until the principles on which it depends, and afterwards the methods of applying it, are cleared from scientific phraseology, and reduced into language so simple, as to be readily understood by the working managers of quarries and mines, and the foremen and agents of contractors engaged in any of those numerous works in which blasting operations are required.

With this preface, then, we shall offer no apology for commencing with so simple an affair as the explanation of what it is that constitutes a galvanic battery. In order that any person may, in a few minutes, construct for himself an apparatus of this kind, it is only necessary to be provided with a common jar, four or five inches in diameter, a small plate of zinc, say two or three inches square, a small piece of copper plate about the same size, a little diluted sulphuric acid, sufficient to fill the jar about half-full, and a few feet in length of copper wire. To construct a battery of these simple materials, we must solder a piece of the wire to each of the plates, and this done, immerse both of them into the jar, half filled with the diluted acid. This is the battery, and the moment the wires of the two plates are connected together, by soldering them to each other, or twisting them together, the battery is in action; that is to say, a current of electricity is in constant circulation from the one plate to the other. It is not known how or why it is that a decomposition of the water mixed with the acid should take place under these circumstances, nor is it known in what way this is connected with galvanic action. We do know, however, that a decomposition of the water does take place, that the oxygen which it contains is absorbed by the zinc, and that hydrogen gas is liberated. It is this liberation of hydrogen gas (one of the components of water) which causes the effervescence when any metal is immersed in a diluted acid. Now it seems that the generation of electricity is in some way connected with this decomposition of the water; and without entering further into this question, it will be sufficient for our present purpose to state, that the electric fluid, when once generated, passes first from the acid to the copper plate, and thence, through the wire, to the zinc plate; and this continual current from the liquid to the copper, and from the copper to the zinc, ceases not to act as long as any of the zinc remains to be oxidated, a sufficient supply of the diluted acid being of course maintained, in order to continue the oxidation.

The current of electricity thus simply and easily produced is an No. XXXV.—DEC. 1, 1842.

agent of surprising power, and is capable of producing many astonishing effects. The one with which we are here more immediately concerned, is its property of raising the temperature of the wire, or other metal through which it passes. It is obvious, that if we can produce in this way so high a temperature as to render the wire, or any small part of it, red hot, we possess at once the power of exploding gunpowder. It has been the object of all those who have turned their attention to the subject of blasting by galvanism, to devise a convenient apparatus for causing at pleasure some small part of the wire, at some distance from the battery, to become red hot at the point where it is in contact with the enclosed charge of powder which it is required to explode.

For this purpose, it has been found necessary to employ a battery with more than one pair of plates, because, however large a single pair might be made, the current produced by their means would not possess what is called the *intensity* required to make it travel along the necessary length of wire. It is known, that increasing the size of the plates, without increasing their number, enables us to produce a great *quantity* of electricity, but of such small intensity, that it would only travel through a very small length of wire. It appears that the power of igniting, or of fusing, possessed by a current of electricity, depends upon the quantity in which it is produced; and its power of overcoming obstacles, or, in other words, the distance it is capable of travelling, depends upon its intensity. Now this latter property can only be acquired by employing several pairs of plates, connected by wires in such a manner as to carry the current from the first to the last throughout the whole series. The electricity from one pair of plates is thus conveyed to another pair, and the compound current from these is conveyed to a third, and so on, till the end of the series, which must be of sufficient extent to give the current the necessary degree of intensity. Now in the following way several pairs of plates may be joined together in series.

Place several jars in a line, each of them half-filled with diluted acid, and into each immerse a zinc and a copper plate, which must be so fixed in a vertical position, as not to be in contact with each other. To each of these plates a piece of wire must be soldered. Now take the wire of the copper plate in the first jar, and fasten it to the zinc plate in the second jar. In the same way fasten the wire of the copper plate in the second jar to the wire of the zinc plate in the third jar; the wire of the copper plate in the third jar to the zinc plate in the fourth jar, and so on, through any number of the plates, always remembering that the wire of each copper plate must go to the zinc plate of the adjacent jar. When the connexion has been made in this manner between the opposite metals throughout the series, it will be found that the wire of the first zinc plate and that of the last copper plate are both loose, and unattached to any other. If we now take round the wire from the last copper plate, and connect it with that from the first zinc plate, the current will at once circulate, and a much more powerful battery will be produced than it is possible to form by a single pair of plates,

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however large. Fig. 1 will render this description more intelligible, the letters *z* and *c* denoting respectively the plates of zinc and copper, and the arrows denoting the direction of the current from the first jar to the last, and back again from the last copper plate to the first zinc plate.

It is evident that the wires attached to these first and last plates may be of any length, providing the battery be of sufficient size and power to send a current through in sufficient quantity; and this being premised, its application to the explosion of gunpowder is very obvious. Thus, conduct the wire from the copper plate to the charge of gunpowder, and make it pass through this so as to be surrounded by the powder, and then convey it close to the free wire of the first zinc plate. Now as long as this wire which passes through the powder is not in actual contact with the zinc plate, or its wire, no action will take place, but the instant the two wires are made to touch each other, the current of electricity passes along the wire, the part of it immersed is fused, or at least is made red hot, and in the same instant, of course, the powder is fired. It must not be supposed that the whole length of the wire is rendered red hot in the same way as that small piece of it which passes through the powder. On the contrary, the piece of wire to be fused must be very thin, and is commonly made of steel, so that the current which is sufficient to make this small piece red hot at so great a distance from the battery, affects the stout copper wire in no greater degree than slightly to raise its temperature for an instant, without producing anything approaching to fusion.

Having now explained how the electric action employed in blasting is obtained, so as to show the origin of the power with which we have to act, we must next come to the means of obtaining and employing this power in a more convenient manner than by using jars, which being brittle, and unconnected with each other, are ill adapted for the use of workmen in the open air.

The apparatus shown in the plate has been contrived by Mr. Roberts, with a special regard to the peculiar circumstances under which it has to be employed in the process of blasting—circumstances so essentially different from those of the lecture-room or the laboratory, that an apparatus which would be in every way most convenient and admirable in the one, might be quite useless and inapplicable in the other.

Figs. 2, 3, 4, and 5 contain an isometrical projection of Mr. Roberts' zinc and copper battery, from which its construction may be understood with great ease. Fig. 2 is a box with cells or partitions which correspond with the jars in the form of battery described above, and when the plates are immersed in these cells, the current circulates through the battery in the same way as if the separate jars were employed. This box may be made of deal or elm, but Mr. Roberts prefers elm: the sides and ends to be of half-inch plank, and its length from out to out 15 inches, and its breadth and depth from out to out each 9 inches.

In the sides of the box, before they are put together, nine grooves are to be cut to admit the wooden partitions, which divide the box into ten cells or compartments. In this form of battery it is essential that the joints, not only at the ends of the box, but at the ends of all the cells, be perfectly water-tight; to effect which white-lead may be employed, or any kind of resinous cement which will resist the heat caused by the effervescence of the acid.

When the box is put together, it will be advisable to coat the whole surface of each of the cells with this resinous cement, which may be thus effected: Pour a little of the cement, when melted to

a fluid state, into one of the cells, and tilt the box on its edge in the several different positions required to make the cement flow up the sides and ends of the cells, and then place it upon its base: the cement will then drain into the bottom, where it will form a smooth surface, and leave only sufficient on the sides to render them impervious to moisture. This mode of coating the cells will be found very easy after a little practice.

The zinc plates to be employed in this wooden battery are 7 inches square, and each cell of the box is to contain one zinc plate, and one double plate of copper. These constitute one galvanic pair, which is thus made:

* A copper plate, 7 inches wide and 17 inches long, is bent into the form of a narrow box or case, without top or bottom,—the joint is not soldered, but merely seamed or clasped together: to the top of this copper case solder a stout copper wire (size No. 10) about 1 inches long.—We have now a copper box, 7 inches deep, 7½ inches long, and 1 inch wide.—(Fig. 3.) To a zinc plate, 7 inches square, solder a wire similar to that fastened to the copper case; let the zinc plate be covered carefully with a single layer of stout brown paper, and the joints or seams of this paper fastened down with wax, or other resinous cement, in such a manner that no liquid can reach the zinc but through the tissue of the paper: the reason of this will be explained in another place. Now, put this covered zinc plate into the copper case, and maintain it in the centre by small pieces of cork; the greatest care should be taken that the zinc plate does not touch its surrounding copper, and also that the wires of these plates do not touch each other, for if any metallic communication be effected between the zinc and copper plates of the same pair, the electricity of that pair will be entirely lost: it is well to round off the corners of the zinc plate to prevent them piercing the brown paper covering. We have now one galvanic pair: let ten of the same kind be made, and these ten pair might be placed in their reservoirs and joined in sequence, as before described for the plates immersed in the jars, but to put them in singly, and then join the wires every time the battery is worked, is so tedious an operation, that it would render the apparatus practically useless; we must therefore place them joined in sequence in a frame of wood. They may then be simultaneously immersed in the reservoirs without any loss of time, and when one blasting operation is finished, the plates can be easily lifted out of the exciting liquid, so as to prevent the waste of the liquid and of the zinc that would take place were the plates to remain in it when the action of the battery is not required.

Fig. 4 is a projection of the frame; it consists of three wooden bars parallel to each other, and joined together by cross ends; it must be 15 inches long and 9 inches wide, the bars to be each an inch and a half square, the use of this frame being to support the copper cases and zinc plates in such a position that all may be simultaneously dipped into the cells of the wooden box: saw-cuts are made in the outer bars of the frame, into which the upper edges of the plates are to be inserted; there will therefore be three cuts for each pair, in each bar, two for the edges of the copper case, and one between them for the edge of the zinc plate. When the plates are thus fastened in the cuts or grooves they will be retained in the centre of the cases, and the cases will also be kept by their grooves in a

* We take this description of the battery and the method of joining the plates in sequence in Mr. Roberts' words from his letter addressed to the Highland and Agricultural Society of Scotland. To this letter, which is now published in the form of a pamphlet, we have been indebted for much of the subsequent part of this article.—ED.

position, that all may fit easily, and at once, into the cells of the wooden box: the centre bar of the frame is to be pierced with holes, two for each pair of plates; through these holes the wires attached to the copper and zinc plates must be drawn, that is to say, one wire through each hole, great care being taken that the wires of the same pair do not touch each other: the wires, when well fastened in these holes, which may be done by a wooden pin, will support the weight of the plates, and prevent their slipping out of the saw-cuts in the side bars of the frame.

The plates being fixed in the frame, the edges inserted into the saw-cuts of the side bars, and their respective wires fastened in the holes of the centre bar, we may now attach the several pair in sequence or galvanic series. Placing the frame before you, take the wire of the zinc plate of the first pair, and bend it out of the way, to remain free, that is, unattached to any other plate; this wire we will call the *negative pole*: then take the wire attached to the copper case of this pair, and also the wire of the zinc plate of the next or second pair, and twist them firmly together, being careful to maintain as perfect and extensive a metallic contact between the wires as possible: it might be well to rub them bright with a file or sand-paper before they are twisted together. The wire of the copper case of the second pair may now be twisted in the same manner with the wire of the zinc plate of the third pair, the copper case of this pair fastened to the zinc of the fourth, and so on until we arrive at the tenth or last pair, the wire of the zinc plate of this being fastened to the copper case wire of the ninth pair: we find that the wire of the copper case of the tenth pair is free, and there remains no zinc plate to which we can attach it,—we therefore bend it outwards, and may call it the *positive pole* of the battery. Here then we have a galvanic battery complete for ordinary purposes, viz., ten cells or reservoirs to contain the exciting solution, ten pair of copper and zinc plates fastened together in galvanic series, and the positive and negative poles free to be applied to any substance we wish acted upon: these poles may be extended to a great length by adding copper wire to them, and the active powers of the battery may thus be conveyed to a considerable distance. For instance, suppose it is wished to burn a fine wire at a distance of 50 yards from the battery, add 50 yards of stout copper wire to the positive pole, to the end of this fasten the fine wire that is to be fused, and to this again attach 50 yards of stout copper wire, the free end of which is to be brought near the negative pole of the battery. Now immerse the plates in the exciting solution contained in the box of cells, and bring the free end of the stout copper wire into contact with the negative pole; the electric fluid instantly circulates from the positive pole through the stout copper wire, then through the fine wire (fusing it), and back through the stout copper wire in contact with the negative pole.

Such is the battery proposed by Mr. Roberts for firing charges of gunpowder. It will be observed that as no effect takes place till the poles are connected with each other, and as the fusion of the fine wire produces no injury to any other part of the wire, the contact might be made by hand if the fine wire were not immersed in the gunpowder. Since the explosion, however, takes place the very instant this contact is effected, there would be danger from splinters of the rock to any person who should make the contact by hand, except at a great distance from the charge of powder. In order to give the advantage of great distance from the place of explosion without increasing the distance of the battery, and consequently the length of wire, Mr. Roberts has contrived an addition

to his apparatus, by means of which the contact can be produced by simply pulling a string, and as this string may be of any length, the operator who fires the charge may place himself entirely out of danger.

Fig. 5 shows the battery with this apparatus attached. It will be seen from this figure that the frame shown in fig. 4 is provided with two uprights at the ends, with an opening about an inch diameter in each. Through these openings passes a round cross-bar of wood. On this cross-bar, close to one of the uprights, is fixed a tin disc *a*, and to this disc is soldered the wire *x* from the negative pole of the battery. The cross bar is also provided with another disc *b*, which is moveable. The opening in the centre of this second disc is about an inch and a half diameter, and into this opening is soldered a short tin tube *t*, about two inches in length, which, sliding on the bar, serves to keep the disc in an upright position when the string is pulled. To this short tube is fixed a spring or spiral wire (such as a bell spring), whose length, when extended, will allow the discs to be in contact, and which, when the string is slackened, will immediately, by coiling up, separate the two discs to the position shown in fig. 5. When the spiral wire is thus coiled the two discs are seven inches apart, and to prevent the possibility of an accidental contact at an improper time, a small pin is inserted into the bar about half way between the two discs, and it is evident that no contact can take place till this is withdrawn.

Suppose now the wire *p* attached to the positive pole of the battery to be soldered to the zinc plate *b*, the pin to be removed, and the string *s* pulled,—the contact will immediately be complete, and the current of galvanism will circulate.

It will be observed that, instead of putting only one plate into each cell of this battery, which would make it exactly correspond with the apparatus of jars above described, there are, in fact, two copper plates and one zinc plate in each cell, because each zinc plate is surrounded, as seen in fig. 3, by a case which opposes a copper surface to each side of the zinc plate. This arrangement gives a much more powerful action to the battery.

Diluted sulphuric acid has been mentioned as the exciting solution to be used in the battery; but it should be observed that Professor Daniell having discovered that great advantage arises from using sulphate of copper for this purpose, Mr. Roberts recommends that the latter should be employed. When this solution is used, however, it is necessary, in order to prevent precipitation of the copper on the zinc plates, that the latter should be covered; and the brown paper which Mr. Roberts recommends possesses the advantage of being quite porous by the solution, while it effectually prevents all deposition on the plate of zinc. It will now be understood why it is directed in the description of the battery that each of the zinc plates should be enveloped in brown paper. If it should be found at any time that a more powerful action is required in the battery than that produced by the sulphate of copper, the effect may always be increased by adding a little sulphuric acid to the solution,—the strength of this will be easily regulated after a little practice with the battery.

We may now describe the conducting wire, which proceeds from the sliding disk and the positive pole of the battery to the charge of gunpowder to be fired. Suppose the battery is to be placed 30 yards from the place of explosion, then 60 yards of conducting wire will be required. This conducting wire should be made of several finer copper wires, twisted together like the threads of a hempen

rope. It thus forms a wire rope, which is flexible even when made an inch or more in diameter. One eighth of an inch, however, is sufficient diameter to give to the wire rope for blasting. This length of 60 yards of rope must now be covered with hard twine; this may be put on by hand, taking care that the several turns of the coil are kept closely in contact with each other. We have now a wire rope 60 yards in length. Cut this rope in half, lay the two lengths of 30 yards each, side by side, and bind them together for their whole length, except about 18 inches at one end. The method of binding them together is by covering the double rope with hard twine, coiled closely round it on the same way as already directed for the single length. This rope must now be permanently attached to the battery, by soldering one projecting end to the wire of the positive pole of the battery, and the other projecting end of the same extremity of the rope to the sliding tin disc. The remaining part of the rope may now be coiled up ready for use.

The battery is now in a condition to be employed for fusing a piece of fine wire. Thus, connect the two projecting extremities of the conducting wire by a piece of fine steel wire, and suppose the plates immersed in the solution, and the whole apparatus in the condition shown in fig. 5, except that the pin between the two disks must be taken out. Now pull the string *s*, so as to bring the disk *b* into contact with *a*, and the electricity immediately circulates from the positive pole of the battery, along one part of the conducting wire, till it comes to the fine wire at its extremity; it fuses this fine wire, and returns through the other part of the conducting wire to the sliding disk, and finally arrives at *a*, the fixed disk, which is the negative pole of the battery. This circulation of the galvanic current is the work of an instant.

We now perceive that the reason for covering the conducting wire with twine is to insulate the two lengths from each other, so that, although they are bound closely together by the outside covering of twine, no electricity can pass from one to the other, without first circulating through the fine wire. It is found that twine is a sufficiently good non-conductor to prevent the electricity produced by this kind of battery from passing directly from one wire to another.

As it would be inconvenient to have at every explosion the trouble of attaching a fine wire to the ends of the conducting wire, Mr. Roberts has contrived a cartridge, a number of which may be kept ready for use, and one may be fastened without loss of time to the conducting wire whenever required. The cartridge is a tin tube filled with gunpowder, and in this are placed the ends of two stout copper wires connected by a fine steel wire; the copper wires are each about ten feet long, and serve to convey the electricity from the conducting wire of the battery to the fine wire immersed in the powder of the cartridge;—these copper wires we will call the communicating wires: the tube is stopped at both ends by corks covered with cement to keep the gunpowder dry; when thus corked and cemented, the cartridge may be fired under water without a risk of failure: the communicating wires must be of sufficient length to extend from the bottom of the bore-hole in the rock, to a few feet above the surface, and as the holes are seldom more than 6 or 8 feet deep, we may take 10 feet as the average length of the communicating wires.—The details of making the cartridges are as follow:

Take 20 feet of stout copper wire covered with cotton thread, double it, and twist the two parts at the looped end closely together for about six inches of their length; then, with a file, or cutting

pliers, cut off the round end of the loop, and the ends will project as horns of half an inch in length; then bare the extreme points of these horns (being about half an inch asunder) of the cotton thread that is around them, and clean them with a file: now take half an inch of fine steel wire, lay it across from horn to horn of the stout wire, and bend each of these horns slightly into the form of a hook. A blow with a hammer will now close the hooks firmly upon the wire, and we have then two long stout copper wires connected at one extremity by a fine steel wire.

As this combination of wires is placed in the bore-hole, it will be exposed to the action of the ignited charge of gunpowder, and without some precaution to secure it would be destroyed by every explosion: to prevent this waste, the communicating wire is first covered with cord (in the same manner as the conducting wire of the battery is covered), and an additional covering is then given of hard whip-cord, or of fine binding-wire,—binding-wire will perhaps be found best, as it effectually prevents the included communicating wires being injured by the broken fragments of the rock: the fine wire fastened to the ends of the communicating wire will be destroyed at each discharge, for the electricity will fuse it, but this fine wire is easily replaced at a cost of three-halfpence for every dozen cartridges:—care must be taken that the horns are well cleaned before the fine wire is fastened to them.

The body of the cartridge (see fig. 6) is a tin tube, 3 inches long, and three quarters of an inch in diameter, of which the joint is soldered, and rendered perfectly water-tight: the fine wire across the horns of the twisted wire is placed in the centre of the tube, and retained firmly in this position by a cork at the end of the tube, through which the twisted wires pass. The best way of fixing the twisted wires is to split a bit of cork half through, lay them in the slit, then force the cork into the tube, and this will jam the wires firmly in the slit; taking care that the horns do not touch the sides of the cartridge, and that the cork is covered with a good cement, as this assists in preserving the horns in their proper position. The cement Mr. Roberts generally uses is composed of one part of bees'-wax, and two of resin, which, if put on hot, readily sets, is very strong, and does not crack in cooling; but any cement that has these properties, and effectually keeps out damp, will answer the purpose.

Having now the tin tube with the fine wire firmly fixed in the centre, the next operation is to fill the cartridge with gunpowder. It must be fine sporting powder, and thoroughly dry: unless this be attended to, the fine wire may be fused by the electric fluid without igniting the charge, for the action is so rapid, that if the powder be damp, it will hardly be dried, much less ignited, by the fusion of the wire—it is therefore important that the powder be put into the tube in a perfectly dry state:—the best method of ensuring this, when a great number of cartridges are made at one time, is to dry the powder over a steam-tight box filled with boiling water, for it would be dangerous to dry a large quantity of powder near a naked fire; but, when a few dozen only of cartridges are required, heat a soup plate by a fire, and when it is a little hotter than the hand can bear, take the plate from the fire, and throw into the plate a sufficient quantity of powder to fill two or three cartridges; shake it in the hot plate for two or three minutes, and then fill the cartridge tubes with the powder, which will now be perfectly dry and warm:—while in this state, cork the ends of the cartridges, and cover the corks with the same kind of cement as that used for the corks through which the wire passes.

Such is the cartridge,—a tin tube, 3 inches long, and about an inch in diameter, filled with dry gunpowder, and having both ends well corked, through one of which pass the ends of two wires twisted together, with their extreme points connected by a fine steel wire immersed in the centre of the gunpowder, the powder in the tube being effectually defended from moisture by the covering of resinous cement.

The kind of steel wire which should be used in making the cartridges, is that called balance wire by the watch-makers. A reel of this wire, containing 6 or 8 yards, costs only 3d., and about two inches of it will be sufficient for each cartridge.

The preceding account, with very slight modifications, is descriptive of the form of battery first designed by Mr. Roberts for blasting operations. It is this kind which has been so extensively employed at his recommendation in the works at Dunbar Harbour, at Skerry Vore Light-house, at quarries in the neighbourhood of Glasgow, and in works of considerable extent on the property of Lord Panmure.

As Mr. Roberts, however, has lately directed his attention to the construction of an apparatus of still greater simplicity, and one more readily constructed than the preceding, which has to be divided into water-tight cells, we have thought it advisable to present our readers with a drawing of this new battery, as well as the other. It is proposed in this battery to use twenty plates of zinc, each 7 inches square, and twenty-one plates of iron of the same size. This substitution of iron for copper somewhat reduces the cost of the apparatus, and the workman will at the same time find the iron battery more easy to construct.

Fig. 7, shows the wooden frame which is made to receive the plates. The ends of this frame are solid boards of the form shown, and the bottom may either be solid, or may consist of two bars, as it is only required to support the plates. The sides consist of bars, as shown in fig. 7. The apparatus for producing contact is also shown in fig. 7. It is somewhat different from that before described, as the disc spring here terminates in a binding screw, *a*, and the wire from the positive pole also terminates in another binding screw, *b*.

Fig. 8, is a view of the frame with the plates placed in it. The plates are placed alternately, that is, an iron plate is put close to one end of the frame, then a zinc plate, then another iron plate, and so on to the end, where the last plate must be of iron, and placed, as at the other end, close to the wood of the frame. If twenty plates of zinc be used, there will thus be twenty-one plates of iron. The iron and zinc must be separated from touching each other by strips of wood $\frac{3}{8}$ of an inch square, and 7 inches in length, that is, as long as the plates are in depth. Two of these strips are placed between each plate, as shown in fig. 8, and their lower ends rest upon the bottom of the frame. The plates should be pressed tightly together, so as to jam the strips of wood closely between them.

Fig. 9, shows the box for containing the solution to excite the plates. This box may be made of $\frac{1}{2}$ inch plank, the joints accurately dovetailed, and cemented with white lead. The sides should be fitted with two uprights or standards, with a sliding pin across from one to the other. This pin serves to support the frame of plates, the cross bar of the frame resting upon it, when the battery is not required to be in action. The frame should always be raised into this position, except when the battery is about to be worked, as it allows the liquid to drip from the plates into the box. The

exciting solution for this battery may be made by mixing sixteen parts of water with one of sulphuric acid.

It remains to describe the mode of connecting the plates in this battery :—

Having the plates arranged before us, as above directed, that is, the first and last plates of the series being of iron, we shall commence with the left-hand extremity of the series, and call the plate there placed the first. Now connect the first and second iron plates, and let them stand free as a double terminal plate, the wire soldered to which is the negative pole of the battery, and must be fastened to the fixed disk. Next connect the first zinc plate with the third iron plate, the second zinc plate with the fourth iron plate, the third zinc plate with the fifth iron plate, the fourth zinc plate with the sixth iron plate, the fifth zinc plate with the seventh iron plate, and so on to the end of the series, when it will be found that the twentieth, or last zinc plate, is unconnected with any other. Then the wire from this last zinc plate must be made to terminate in one of the binding screws. Thick wires or strips of metal are to be used for connecting the plates as above described, and they should be carefully soldered to the proper plates.

We cannot do better than extract from Mr. Roberts's letter before-mentioned, the following detail of the process of blasting by his apparatus :—

When a rock is to be rent by the explosive force of gunpowder, the first thing done is to bore in the rock a hole, of a depth and diameter proportioned to the strength of the stone and the quantity we wish detached. Let us, for example, suppose the hole to be 6 feet deep and 2 inches in diameter: cleanse it from dust and moisture by passing a straw or oakum wad several times through it, then lightly pour into the hole half the intended charge of gunpowder; put a cartridge upon this, and upon the cartridge pour the remainder of the charge;—do not ram the powder down, for the lighter it lies together the better: the cartridge will thus be in the centre of the charge, and its long communicating wires will project 3 or 4 feet above the surface of the rock. The charge of powder and cartridge will fill about 8 or 10 inches of the hole.

The next operation is tamping. Thrust a straw or oakum wad gently down the bore-hole until it is about 2½ feet from the surface; this done, there remains an empty space (that is to say, a space containing merely atmospheric air) of about 2½ feet in depth between the wad and the gunpowder. In practice it is found of great importance to allow this distance to exist between the powder and the wad, for the expansion of the air by the flame of the ignited powder adds to the rending force, and there is also an effect produced similar to that when a ball is rammed but half-way down a musket-barrel—it is well known that a very small charge of powder will burst a musket so loaded; however, be the cause what it may, it is always found the rending force of the powder is much increased by allowing an empty space to remain between it and the tamping-stuff, and also that, by so doing, there is less chance of blowing out the tamping-stuff. When the wad is in its proper place, fill the hole up to the surface of the rock with dry sand;—it may be gently pressed down by a wooden rod, but this is of little consequence. The hole is now charged, and about 4 feet of the cartridge communicating wires project above the surface of the rock.

Having filled the box of the battery with a saturated solution of sulphate of copper mixed with a little sulphuric acid—(with diluted sulphuric acid only if the iron battery is to be used)—place it at some convenient distance from the rock, behind a large stone, or in

any situation where it is not likely to receive injury from the falling fragments of the rock; put the frame of plates on the ground by the side of the box, and be careful the safety pin is in the hole prepared for it; then unroll the conducting wire, and attach the ends that are free to the cartridge communicating wires projecting above the surface of the rock. This may be done by twisting them together, but it will be better that a binding-screw be soldered to each free end of the conducting wire, and to these the communicating wires are readily attached by inserting an end into each screw, two or three turns of which will make the contact perfect: this contrivance will be found of great service, because the cartridge can be attached to the conducting wire without loss of time, a good metallic contact between them is ensured, and, if the binding-screws are covered with cotton, varnish, or some other insulating substance, there will be no metallic contact between the separate parts of the conducting wire, and this should be avoided, because it would open a channel to divert the electric fluid from its proper course; and it should always be remembered, that no two wires must be in metallic contact with each other, except at the points where the electricity should pass from one to the other. If binding-screws are not used, and the conducting and communicating wires simply twisted together, these uncovered portions of the conducting channel must be insulated from each other by a covering of paper or cotton, but it is far better to use screws:—they cost about 1s. each.

When the cartridge has been fastened to the conducting wire of the battery, unroll the lanyard (that is, the string attached to the sliding disc), and carry the end to a situation where the operator can stand in perfect safety. Every one must now retire from the rock, except one person, whose office will be to ascertain that the safety-pin is in its place, and that the discs do not touch each other; he is then to place the box in such a position that its end shall be towards the point from which the lanyard is pulled; he then puts the frame of plates into the box,—a pair of plates into each cell, being careful the fixed disc is towards the place where he stands to pull the lanyard: the safety-pin must now be taken out, and the operator retires to the place where the lanyard has already been laid; he then pulls the lanyard slowly and steadily, without a jerking motion, the moveable disc slides into contact with the fixed disc, the electricity circulates, and the charge of gunpowder is exploded.

The operator must then return to the battery and remove the plates from the cells, coil up the lanyard, detach the conducting wire from the cartridge communicating wires, and coil it up; the communicating wires, most probably, will be found jammed between the fragments of the rock, and there they must remain until released by carrying away the stones, when the wires will be found uninjured; if they are forcibly pulled out from the fragments of rock they may be broken: the tin tube and fine wire of the cartridge will be destroyed by the force of the explosion, but the communicating wires will serve for another cartridge. It sometimes happens, that if the battery has not been used for some days, the papers that are round the zinc become so dry that time is required for the exciting solution to penetrate through them to the zinc; and if an attempt be made to work the battery before the paper is well saturated with the liquid, it is probable no electricity will circulate: to avoid such a disappointment, either dip the frame of plates into a tub of water for the space of five or ten minutes, or allow the plates to remain for a few minutes in the battery cells before the lanyard is pulled.

Should it be necessary to fire a charge under water, the cartridge must be well covered with resinous cement, and the charge of pow-

der surrounded by a water-tight covering, such as a tin canister: the cartridge must in this, as in the case of blasting rocks, be placed in the centre of the main charge. When the canister containing the powder is lowered or veered out, care must be taken that no strain is laid upon the communicating or conducting wires, and to ensure this the canister should be attached to a rope, upon which the whole weight must depend; but, as this manipulation is easy, and as it must vary so much with circumstances, it is needless to enter into any detail of the method,—the ingenuity of the parties employed will be sufficient to meet all the exigencies of this very simple part of the process of blasting.

Mr. Roberts recommends, for blasting horizontal holes in a rock, especially if wet, that the *whole charge* used be contained in a tin or strong paper cartridge;—in this way, a hole may be charged with powder in one second (the cartridge, of course, having the galvanic wires in it); while to charge a horizontal hole, or one rising upwards, on the old system, required many minutes, with much waste of powder.

FIRING SEVERAL CHARGES SIMULTANEOUSLY.

This is an operation which produces an astonishing effect in blasting, and should therefore always be resorted to in extensive works. If several charges of powder are placed in a line with each other in a rock, and all fired simultaneously, they will detach a much larger mass of stone than if the same quantity of powder had been exploded in one hole. This simultaneous firing of charges was found of great service at Skerryvore Lighthouse, which was erected under the superintendence of Mr. Allan Stevenson, who has employed Mr. Roberts' galvanic apparatus with great success in his blasting operations.

In firing charges simultaneously, one conductor or main channel is laid above and in a line with the several cartridges and charges in the rock, and from this main conductor, which is the conducting wire, off-sets or branch conductors (the cartridge communicating wires) lead to the several charges of powder in the rock. When the cartridges are arranged in this manner the firing of all is ensured; for the finest wire being fused, the electric fluid that was here employed flows along the main branch to assist in fusing the next weakest wire, and so on throughout the whole series; but as the velocity with which electricity travels is too great to be perceptible in this short distance, the cartridges are all fired at the same moment.

The best manner of connecting the communicating wires (the branch channels) to the conducting wire (the main channel), is to have binding-screws soldered to the conducting wire at intervals, corresponding to the usual distances between holes bored in a rock for simultaneous firing,—say at intervals of 8 or 10 feet: the ends of the communicating wires can be inserted into these binding-screws in the same manner as the communicating wires are attached to the end of the conducting wire; but, if binding-screws are not used, those parts of the conducting wire opposite to the holes where the charges are placed must be uncovered from the thread and varnish round them, and the communicating wires twisted round these naked portions of the conducting wire; these points of junction are to be then covered with paper, or some other insulating substance: but the binding-screws are most convenient, and the cost of them but trifling.

Mr. Roberts strongly insists on the importance of proving, by means of a galvanometer, first, that no current will circulate through

the communicating wire till the piece of fine steel wire is placed between the ends;—and, secondly, that the current *will* circulate when the steel wire is interposed. These proofs are, of course, very important, to prevent any disappointment from the failure of the cartridge, or from metallic contact which might exist between the parts of the wire rope otherwise than through the fine wire.

The action of the galvanometer depends on this principle, that if a current of electricity flow through a wire, and a magnetic needle be suspended, free to move, above it, the needle has a tendency to place itself at right angles or across the wire through which the electric fluid is passing;—if the wire be in the magnetic meridian, the needle, instead of pointing north and south, its natural direction, will now point east and west. When the current of electricity is interrupted, the needle will return to its natural position, and an apparatus on this principle, called a galvanometer, is used to detect currents of electricity. A wire, through which the electricity is to circulate, is bent several times round a needle, because each duplication increases the action of the electricity on the needle, and thus renders it sensible to feeble currents.

To construct this kind of galvanometer, take about ten or twelve feet of copper wire covered with cotton thread, and bend it round a rectangular block of wood, of about three inches long, and an inch in depth; let the ends of the wire project on one side of the rectangle; take out the block of wood, and you have now a rectangular coil of wire, a little more than three inches long, and an inch in depth; there will be about thirteen coils; tie them together, and fix them upon a wooden stand. In the centre of the coil, and resting on the inside of the lower part, fix perpendicularly a fine steel point, about half an inch long,—a bit of a fine sewing needle will answer the purpose,—and it may be fastened with sealing-wax. This steel point is the support of a magnetic needle, about two and a half inches long, having a central pivot to rest on the steel point. Such a needle can be purchased of a philosophical instrument-maker for 1s. 6d.

If the needle be placed on its pivot, and the rectangular coil of wire be in the magnetic meridian, the needle will vibrate for a few moments, and then settle in a direction parallel to the length of the coil; then, if one wire or pole of a galvanic pair be fastened to one of the projecting ends of the coil, and the other pole of the galvanic pair be made to touch the other projecting end of the coil, a current of electricity circulates round the coil, the needle flies out of its natural position, and points, more or less, towards the east and west, in proportion to the strength of the electric current.

If, instead of making both poles of the galvanic pair touch the projecting wires, a communication be made between one of the poles and the galvanometer by an independent wire, one end of which is in contact with the wire of the galvanometer, and the other end in contact with the pole of the galvanic pair, the same phenomenon will ensue, because a metallic communication is maintained between them, and the electric fluid can circulate round the coil as before, causing the needle to deviate from its natural position. If this communicating wire be broken, the needle will not move from the magnetic meridian, thus proving the channel for the electric fluid to be defective; and on this principle the cartridges are proved in the following manner:—One pole of a galvanic pair is put into contact with one wire or pole of the galvanometer; the other pole of the galvanic pair is joined to one of the long communicating wires of the cartridge, while the other communicating wire is in contact with the other wire or pole of the galvanometer.

If the cartridge be perfect—that is, if the fine wire in the centre of the gunpowder be not broken, and if it be well secured to the horns of the communicating wires, the electric fluid passes from one pole of the galvanic pair through one of the communicating wires of the cartridge, from this through the fine wire in the powder, then to the other communicating wire, from this through every turn or convolution of the galvanometer, and back to the other pole of the galvanic pair. The needle in the centre of the coil flying round, proves the passage of the electric fluid. If the fine wire be broken, or not well fastened to the horns, the needle will not move from its natural direction, because no electricity flows through the coil.

It will be noticed, that a single galvanic pair is mentioned for proving the cartridge, and not a compound galvanic battery; the reason must be obvious, for all will see, that if a considerable power of electricity be employed, the cartridge will explode. A galvanic battery, or even a large galvanic pair, would create too much electricity to be with safety passed through the cartridge; but, with the use of a single pair, of one square inch surface, there will be no danger of igniting the powder. The electricity generated by this pair will be sufficient to deviate the magnetic needle from its natural position, but too feeble to heat the fine steel wire immersed in the powder.

Such a galvanic pair may always be attached to the galvanometer, and is thus arranged:—To one projecting wire or pole of the galvanometer is soldered a copper cup, about two inches high, and one inch in diameter; this cup must be water-tight, and fixed upright to the wooden stand; a tin disc, about an inch in diameter, is soldered to the other projecting wire or pole of the galvanometer, and fastened flat upon the wooden stand; a zinc rod, about half an inch in diameter, and two inches long, has a wire four inches long soldered to it, and at the end of this is a tin disc, which is fastened to the wooden stand, a few inches from the other disc; the zinc rod is covered with brown paper. When it is required to use the apparatus, fill the copper cup with a solution of sulphate of copper, and dip the zinc rod into the copper cup; in a few minutes the solution will have soaked through the brown paper to the zinc, and the galvanometer will then be ready for proving the cartridges. Place the apparatus in such a position, that the length of the coil be in the magnetic meridian, poise the needle on its pivot, and it will stand parallel to the length of the coil; now press the end of one of the cartridge communicating wires upon either of the tin discs of the galvanometer, and let the other tin disc also be in good metallic contact with the other communicating wire. If the cartridge be in good order, the electric fluid flows from the copper cup through the coils of the galvanometer, then through the cartridge, and back to the zinc rod; the needle spins round, and will finally settle at right angles to the meridian: but, if the cartridge is not perfect, the needle will not move, and the cartridge must, in this state, be discarded, or it may be opened, and probably the fault can at once be discovered and remedied. “I have generally,” says Mr. [unclear], “made it a practice to prove every cartridge twice—once before it is filled with powder, and again when the cartridge is finished.”

In proving the communicating wires of the cartridge before the fine wire is inserted, the experiment of course is the converse of that just described, because, if the needle is affected before the fine wire is placed at the end it is clear that metallic contact exists somewhere between the two wires. If the needle be found to move before the fine wire is attached, the communicating wires must be

carefully examined, and the connecting parts insulated, for without this, no electricity will pass through the fine wire.

In describing the method of tamping the bore, it will be observed that an empty space of about 2½ feet is to be left between the gunpowder and the tamping; and that the tamping itself is to consist of loose sand, without any ramming whatever. We are informed, that although loose sand might possibly blow out if no space were left, this has never been known to occur when a space has been left as described.

It is a well-known fact, that if a musket be fired off with the bullet in its muzzle instead of being rammed down, it will be almost certain to burst;—and it is known, also, that the bursting of fowling pieces is very frequently occasioned by a little snow, sand, or mould just plugging the extreme muzzle. Mr. Roberts, in referring to these facts, believes it will be found by calculation that the force of gunpowder is some thousand times greater with a small space above it, than when no space is left.

Correspondents of the *Mechanics' Magazine*, and other periodicals, have also, at different times, stated, from their own actual practice, the great advantages derived from firing simultaneous charges by galvanism. One, in particular, writing a few weeks ago from Liverpool, states, that with 10 pounds of powder he did as much work by simultaneous charges, as he could with 100 pounds by successive charges. Mr. Roberts has been assured, that similar results were obtained by Mr. Wilson, in some extensive blasting operations on Lord Panmure's property.

With such strong evidence before us in favour of these improvements, we should recommend that any persons who may be induced by this description to make trial of Mr. Roberts' apparatus, should at the same time practise the tamping with dry sand, leaving a space between it and the powder; and should, also, if the works are on a scale of any magnitude, adopt the system of firing simultaneous charges.

Since the application of galvanism to the blasting of rocks was first brought into practice, several kinds of battery have been constructed by different persons, which possess great merit in point of durability, power, and economy of construction. We may mention in particular, a very elegant and powerful battery, of extreme portability, proposed and constructed by J. A. Van Melsen, of Maestricht, and of which an account will be found in the *Proceedings of the London Electrical Society*, part iii. p. 184.

Taking every circumstance, however, into consideration, one of the two forms of battery here described and shown in the Plate, will probably be found the best adapted for the actual work of blasting. Of these the copper battery is the most powerful, and the best adapted for a large work, where the operations are to be continued for a long time. The other will answer sufficiently well for quarries required to be worked only for a limited time, and for most of the works of contractors when blasting has to be employed.

Should any part of the preceding description be found imperfect, or unintelligible, to any of our readers, we shall be happy to give any further information on the subject, as we are most anxious to render the whole process as well and as generally understood as it deserves to be, with a view to its universal adoption throughout the country.

BARS OF RIVERS.

TO THE EDITOR.

SIR,

YOUR correspondent, W. G., in this month's *Journal*, writes, "Now as the depth of water on bars is less than in other parts of rivers, the velocity will be proportionably greater, therefore no deposition can take place on the bars, from diminished velocity of the river." W. G., in the above, forgets the operation of the flood tide. Your correspondent subsequently advances his opinion, that river bars "are to be attributed to the action of waves," and his theory differs solely from that by Col. Emy where a distinction is drawn by the latter between his ground waves, "*flots de fond*," and ordinary waves.

The following extract, from page 16 of my work, is a reply to such theories:—

"From my own personal examination of bar rivers, I do not find that any material alteration takes place in the depth of their entrances; and certainly during a succession of long calms, no increased depth is attained, such as should be produced by Col. Emy's theory; indeed, according to his views, during long calms all bars should disappear; but we know that this is not the case.

"Happily his theory is not correct, for if it were, we should find so great an alteration during the long continuance of on-shore gales of wind, that the mouths of rivers would be totally unserviceable when most required for refuge."

The well-known fact that *banks of shingle* are thrown upon some coasts by the action of waves, can with as little reason be advanced as a proof that *bars* are to be attributed to the action of waves, as it would be to state that in other cases these waves exert their influence in an opposite direction, or by the removal of detritus seaward.

In another portion of my work, I have shown that bars exist independent of the embouchure of a river being in a sheltered or in an exposed situation. Certainly W. G.'s observations have differed widely from mine; I beg, however, permission to state, that I shall feel much greater pleasure in replying to those of your correspondents who to their opinions subscribe their names.

In reference to my letter of the 17th of September, on "*Refuge Harbours*," I have merely to request that you and your correspondents will be pleased to bear in mind, that by a *refuge* harbour is meant a place to run to for shelter from the storm or enemy, and not a mere harbour which shall be solely best adapted as a sallying point, from which a hostile coast or marine may be attacked, such as the proposed *naval* station at Dover. In military parlance, the latter might be termed "*the salient angle*," and the former, or refuge harbour, "*the re-entering angle*."

It was with great pleasure that I read your invitation to your correspondents to express their opinions on that most important subject, "*the cause of the formation of river bars*." It is only by discussion that error can be dispelled and truth diffused. And in conclusion I have only to remark, that from the mass of practical data on rivers which I have collected, I feel quite confident, that when you fulfil your pledge, in page 276 of your October number, your data will be found to fully corroborate my theory.

I am, your most obedient servant,

W. A. BROOKS.

Guildhall, Newcastle-on-Tyne, Nov. 3rd., 1842.

SOME ACCOUNT OF THE EMBANKMENT ACROSS LOUGH SWILLY.

NOW IN PROGRESS UNDER THE DIRECTION OF JOHN MACNEIL, ESQ.

LOUGH SWILLY, on the north coast of Ireland, is an arm of the sea, extending into the county of Donegal about twenty-five miles. The first twelve miles from the sea is in a south-easterly direction as far as Buncrana, the next six miles has a southerly direction, and the remaining length extends in a south-westerly direction as far as Leck, where the river Swilly empties itself into the Lough. Opposite the town of Fahan, about four miles south of Buncrana, commences the island of Inch, which is entirely surrounded by the Lough. The southern side of this island is opposite a place called Bert, which is a promontory on the main land. Between Fahan and Bert the shore of the Lough curves greatly to the east, forming a deeply indented bay in the direction of Culmore Fort on Lough Foyle, and with the exception of a neck about five miles in breadth, insulating the barony of Innishowen from the rest of the county. It has been proposed on several occasions to construct embankments at each extremity of Inch Island, in order to connect it with the main land. This would reclaim the whole bay on the east side of Inch Island, and bring several thousand acres into profitable cultivation, and also form a direct communication between Bert and Fahan. The embankment at present in progress, however, is not a work of such magnitude as that we have spoken of across to Inch Island. The object of the present embankment is to cut off a bay of the Lough on the south side of Bert, for which purpose it is necessary to connect the promontory of Bert with a projecting point on the other side of the bay. The effect of this will be to enclose about 1200 acres of land.

It appears that in the first instance there was a good deal of mismanagement connected with the progress of this embankment. We understand that the works were at first placed in the hands of a contractor, who found himself unable to carry them on; the embankment was then worked by the Company, and it was not till nearly three years after its commencement that it came into the hands of the present intelligent contractor. We are not aware whether the effect we are about to mention was attributable to the bad management we have alluded to, or whether greater attention to the nature of the bottom, with a view of joining the two ends of the embankment at a more eligible place, would have prevented this effect; but, however this may be, it will be useful to describe it. When the two ends of the embankment, which had been commenced from each side of the bay, came to be joined together nearly in the centre, it was found that the sandy bottom of the Lough, which originally had been exposed at low water, had, by the greater force given to the water in confining its channel, been scoured out to a great depth, so that when the embankment was near closing the water was not less than 22 feet in depth. We repeat, that we are not aware whether in the present instance the serious increase of the work thus occasioned could have been avoided by carrying on the two ends in different proportions, so as to effect a meeting where the bottom would not so easily have yielded; but whether this could have been done or not in the present work, or whether or not any other expedient would have prevented it, the hint afforded by this illustration will not be lost upon those of our readers concerned in similar works.

It was specified by the engineer that the embankment towards

the Lough was to have a slope of 5 to 1, and towards the land of 2 to 1, and that both sides were to be faced with stone. The method at first adopted for procuring this stone evinced great want of skill and judgment. As it seemed that a supply could only be procured from the neighbourhood of Bert, a number of small quarries were opened at every spot where stone appeared above the surface. These quarries were scattered about in many directions, some of them a mile from any part of the embankment and the stone was conveyed to the shore of the Lough in carts, and then taken to the embankment by boating. This mode of removal was very expensive, and no railroads were laid down for any purpose but that of carrying the clay to make up the body of the embankment. Such was the miserable inefficiency of this mode of working, and so slow the supply of stone, that the ends of the embankment were sometimes left quite unprotected, and it was no uncommon thing for the labour of a whole month to be destroyed by a single tide; waggons, rails, and materials of every kind being swept away to a very serious amount.

This state of things continued up to the spring of the present year, when the work came into the hands of the present spirited contractor, whose method of working it may be useful to describe.

At that end of the embankment which communicates with Bert, and near the side of the Lough, the ground rises considerably towards the land, and in many places along the surface of this hill the stone crops out. There seemed little doubt, therefore, that by cutting into this hill plenty of stone might be obtained; and, accordingly, acting upon this principle, the contractor commenced a gullet into the hill in the direct line of the embankment, and soon found that his expectations were not groundless, as before the gullet had penetrated the hill a distance of 40 yards, an abundant supply of stone was found. All the stuff removed from the gullet proved at the same time a most admirable material for the body of the embankment, as it consisted of clay strongly impregnated with oxide of iron. The gullet was about ten feet deep, and was in the first instance just wide enough to allow the waggons to travel on the railroad, which extended to the tip. The gullet was then widened, and a great many men placed in the quarry—where as many roads were always kept as the space would allow—the boating was almost dispensed with, night and day shifts were engaged, and the work then progressed rapidly, and to the satisfaction of all parties. As it was found that the receding tide was the one most injurious to the embankment, the inner corner of the Bert embankment was kept a short distance in advance; and when the space between the two tips had been reduced to 60 or 70 feet, it was thought advisable to carry the remaining part on at a lower level, in order to complete the junction of the banks as speedily as possible. Accordingly the bank was made to descend as it approached the opposite one, and soon afterwards the contractor adopted the precaution of pitching the whole of the top of the bank as well as the side; and this proved an excellent means of preserving the tip.

The contractor also adopted the expedient of sinking in the middle, where the two embankments were to meet, a rough wooden caisson, about 12 feet in length, the same in breadth, and about 10 feet in depth. This caisson was filled with stones and sunk between the two ends of the embankment, when the tips had met at the bottom, and were about 20 feet apart at the top. Sacks filled with clay to the number of 150 were also sunk on one side of the caisson. Notwithstanding these precautions, we regret to add that the contractor on one occasion sustained the misfortune

of having the bank broken through by the tide where the stone road had been advanced so as to meet the embankment from the other side, whilst the main body was 15 or 20 feet behind. At the same time we have the satisfaction of stating that the damage has been since repaired, and that the bank was in a fair way of being closed when our last accounts were received.

ENGINEERING WORKS IN IRELAND.

[We give in another part of this Journal some account of the work in progress at Lough Swilly; and viewing Ireland as one of the most important fields to which the engineer's attention can at this time be directed, we avail ourselves of the following remarks, with which an able correspondent has favoured us, on the general subject of improvement in Ireland, and particularly that which might be effected by lowering the waters of Lough Erne.—ED.]

There is no country in Europe whose physical character and artificial state are more anomalous, than those of Ireland. The immense Atlantic supplies her atmosphere with constant humidity and abundant rain, which, falling on a soil of more than average fertility, produces that permanence of vegetation which is characterized by the epithet "Green Isle," and which is not greatly checked by those extremities of temperature common to some other countries. On her undulating and semi-mountainous surface, these furnish a source of water-power probably not equalled by those in the much larger extent of England; for in Ireland the evaporation is less, and at the same time the supply is more abundant. In this country are ample stores of mineral treasures, comprising many of the most valuable and rarest kinds, bays and harbours frequented by shoals of fish, and highly fitted for commercial purposes, partial communications throughout by the numerous lakes and rivers; in fact no country exhibits greater sources of wealth, or a more perfect state of physical capabilities for improvement.

Nor is there any country in Europe whose circumstances call more loudly for the development of its natural resources. Densely crowded by a most prolific population, inundating every species of employment in Great Britain, they have divided and sub-divided their miniature farms at home, until these have long ago ceased to furnish more than a mere moiety of either subsistence or employment to themselves or their families. This want of food and want of employment, together with the excitability of the Hibernian temperament, furnish a fine field for demagogues and agitators, and also an excellent soil for the growth of faction and discord.

The Duke of Wellington, with great wisdom, long ago advocated the necessity of employment as a remedy for this state of society. There is no apathy or indisposition with respect to work in Ireland: it is simply because work cannot be obtained, that the population is so much unemployed. Very few have the capital, and fewer still the spirit of enterprise, which would lead them to invest it in improvements of any kind having the character of public benefits. The total amount of navigable rivers, canals, and railroads, both made and in progress, is not more than about 600 miles, while those of England and Wales amount to about 6000, a wide difference, after due allowance is made for the greater size of the latter country. The amount of waste land, according to the Third Report of the Emigration Committee, is about 7,000,000 of acres, five of which are capable of improvement. The innumerable lakes which are scattered over the country also afford ample room

for improvement and means of employment, and in some instances they would not require a great outlay of capital to bring part of the ground they cover into a state of cultivation.

Lough or Lake Erne, nearly all in the county of Fermanagh, merits particular notice as an example. It is divided into the upper and lower lakes, united by a narrow arm, about six miles long, which is rather a part of the river Erne than of the lake. The area of the lake, according to the Ordnance Survey, is 36,348 acres, and its surface has an elevation of 148 feet above low water of the sea at spring tides; this is the lowest summer level. About the end of September or October, according to the wetness of the season, the water of the lake begins gradually to rise from two to four inches per day, becoming occasionally stationary, or decreasing a little, according to the weather. Its greatest rise is usually about six to eight feet, and this height it attains about the middle of December; it continues in this state about two or three months, and gradually falls, as it rose, until it attains near to its summer level, about April or May. The time of its rise, height, and fall, and continuance of its winter level, of course vary with the wetness or dryness of the seasons. The country adjacent to the lake is generally not much higher than the lake itself, and begins to be flooded when the lake has risen about two feet. It leaves neither a useful nor an injurious deposition on the land, for its waters, on entering the bed of the lake, attain almost a state of repose, and therefore deposit in the lake all the matter held in mechanical suspension. An extent of ground, nearly equal to the area of the lough, is flooded by it; the land subject to the floods is chiefly situated on the eastern side of the upper lake. Nearly all the ground thus periodically flooded is pasture, and is much injured by being so long covered with the water, being kept cold, having its vegetation long delayed in the spring, and the soluble part of the manure carried away.

This lake affords a larger extent of navigable surface than any in Ireland, and especially in winter. Numerous small villages are situated on its banks and on the hills, scattered through the flooded part of the country. It furnishes a communication with these villages, and with five market towns—Belturbet, situated on the river Erne, in the county of Cavan; Enniskillen, on an island in that portion of the river which joins the two lakes; Lisnaskea, on the east side of the flooded portion of the upper lake, and two others in the lower lake. The Ulster canal also connects it with Lough Neagh, and several important towns.

Several small rivers discharge into Lough Erne, but its basin being comparatively narrow, and bounded by elevated ground, from 500 to 2000 feet in height, the courses of these rivers are short and rapid, being navigable only from one to three miles in winter, and scarcely at all in summer. The rivers being thus circumstanced, bring to the lake sand and shingle, which is spread in shoals, nearly dry in summer, obstructing the communication with the lake at this season.

The extreme difference between the levels of the upper and lower lake is two feet ten inches, and their mean difference is twenty inches. The general depth of water in the upper lake is about twenty feet, and in some places it extends to seventy. The lower lake is much the deeper, exceeding 200 feet in some places. The upper lake receiving more and larger rivers and streams, has been more filled by depositions from them; while the lower presents its natural bottom of bluish clay, the bed of the upper is of water-borne materials. The country immediately adjoining the lake is

very undulating, the section of the hills and valleys forming almost a series of waves in all directions, and especially about the lower lake. The numerous islands, which rise about fifty feet above the water, show the bed of the lake to be similar to the adjoining country, and that it occupies the lowest part of an excavation in all its extent, having the same features as its basin. This basin of the lake consists of the mountain or carboniferous limestone, which is commonly capped by red sandstone in all points rising above 500 or 600 feet, the limestone appearing in all the valleys between them.

The outlet of the lake is by the river Erne, the length from the lake to Donegal Bay being about nine miles; the first six from the bay are occupied by falls and rapids, which of course cut off all navigable connexion with the sea. The southern arm of the Erne river extends across the county of Cavan into that of Longford, and dilates into two or three lakes; but these are of inconsiderable magnitude, and their navigable connexion with the Fermanagh part of the lake is obstructed by falls and rapids, amounting to about ten feet, at and near to Belturbet.

By lowering the falls at the north end of this lake near the sea, its flooding propensities might be checked; and without any very considerable outlay, a vast quantity of land might be rescued from the annoyance of being covered by water four or five months in the year. It should be observed, that at present the flooding materially interrupts the regular course of cultivation, without, as we have seen, producing any but injurious results. It may be estimated, that the effect of lowering the surface of the lake about thirty feet, would be to lay dry about 18,000 acres, which at present are permanently covered by water, and at the same time give a greatly increased value to about 30,000 acres, which are now subject to periodical floods.

Here is an improvement which would do more good to Ireland than will ever be effected by the political agitation of a thousand years. It is an enterprize which would reflect more credit upon the government who should have the spirited sagacity to undertake it, than any one of those measures of political reform with which this age so much abounds; and this will still be the case, even supposing, which is at least doubtful, that these reforms shall turn out all that their most sanguine supporters anticipate.

LITHOLOGY; OR, OBSERVATIONS ON STONE FOR BUILDING. By C. H. SMITH.

FROM THE TRANSACTIONS OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS.

(Continued from page 295.)

At the Isle of Portland there are the remains of several buildings that were erected with stone from the neighbouring quarries, long before that material was generally known, or considered of sufficient value to be used in the construction of the principal buildings of the metropolis. A large portion of the island has been the property of the crown during many centuries; and so early as the reign of Henry VIII. that monarch caused a castle to be erected at Portland, and another on the opposite shore, near Weymouth: one of these has been continued as a garrison to the present time,—the other has long since been left to ruin; nevertheless, the stone with which the walls are built does not appear to have undergone any decomposition worthy of notice.

Holinshed, who wrote his *Chronicles of England* prior to the

year 1574, has given rather a long account of Portland Isle; he has also in another part of his works devoted an entire chapter to the subject of "Quarries of Stone for Building;" but in neither case has he made the slightest allusion to Portland stone. Camden, the historian (who died in 1623), has also minutely described the island of Portland, without mentioning the stone quarries; and it is worthy of remark, that in the next paragraph he describes the island of Purbeck, distant about 15 or 20 miles, as having "many sorts of good stone, from which large quantities are carried to London, to the great advantage of the inhabitants." From these two eminent writers being wholly silent on the subject of Portland stone, we may reasonably infer that at that time it was a material not generally known or used, except in the immediate vicinity of the quarries.

James the First appointed Inigo Jones his chief architect, and surveyor-general of his majesty's works. Under this appointment, he had to survey the crown lands at Portland; and his discrimination very soon led to the introduction of Portland stone for all the principal buildings in and about London. The banqueting-room, or military chapel, at Whitehall, was begun in the year 1619, and finished in two years.

As far as I can search or learn, this is the earliest building of magnitude constructed with Portland stone in London, or at any considerable distance from the quarries. In 1631, Inigo Jones received orders to repair the old cathedral of St. Paul's; this was performed by "casing great part of the outside, and adding a grand Corinthian portico to the west front, all of Portland stone." From that time it became the chief material used for ornamental architecture, not only in the south of England, but in many parts round the coasts of this country and Ireland.

After the fire of London, in 1666, up to the beginning of the present century, the architects and builders of London scarcely ever thought of using any other kind of stone, except for pavements and similar subordinate purposes. Sir Christopher Wren used Portland stone for St. Paul's cathedral, and other public buildings, because he considered it the best material then known, and on account of the quarries belonging to the crown, as well as their being most eligibly situated for water carriage. Amongst the writings of Sir Christopher Wren relative to the stone for St. Paul's, he states that "all the most eminent masons of England were of opinion that stone of the largest scantlings were there to be found, or no where. An inquiry was made after all the good stone that England afforded, and next to Portland, Rock Abbey stone, and some others in Yorkshire, seemed the best and most durable; but large stone for the Paul's work was not easily to be had even there."

At first, all the stone brought from Portland was obtained from the crown lands on the north-east of the island; but as the demand increased, private property in different parts became more valuable, and large quantities of stone were brought from the west and south-east cliffs, without the slightest regard to quality, durability, or any other consideration of fitness, except that of meeting with an immediate sale in the market. I have carefully looked over many specifications for public and private buildings, and find the materials usually described to be of the best quality; but the general tenor of those parts describing the stone to be used rarely amounts to anything more than the mere well-known name, preceded by an adjective, such as "good Portland stone;" but what is to constitute that "goodness" is altogether undefined.

Large quantities of Portland stone of an inferior quality are brought to London, not because the island is deficient in the best

kind, but because all our large buildings are executed by contracts at so remarkably low a price, that the mason's study is not what kind of stone will be most desirable, but what stone can be wrought by the workman most expeditiously, and thereby yield the largest profit; and of course the proprietor of the quarries will only send such stone into the market as is likely to suit his customers.

St. Paul's cathedral, and many of the churches and other large buildings erected in the reign of queen Anne, were constructed with stone very superior, as far as regards durability, to the greater quantity now used; and yet the quarries from whence those sources are derived have been deserted beyond the memory of any inhabitants now living at Portland, and the only reason assigned is because the merchants find they cannot sell such stone, on account of its being a little harder, and thereby more expensive to work.

Whenever a number of large buildings are being erected at the same time, the demand for stone of the best quality is greater than the quarries already opened can supply. The contractors are bound, under a heavy penalty, to finish the work by a given time, and hence are compelled to use a material which perhaps they would otherwise reject. It may be owing to circumstances of this kind, that portions of the stones used in buildings so recently erected as the park entrances from Piccadilly, are already in a state of decomposition; the same remarks may be applied to some of the stone used about the new buildings of the British Museum. Most of you are probably aware of the deplorable condition that Blackfriars bridge was in before the repairs were commenced. I have been informed by persons who recollect the building of it, that the masonry presented innumerable evidences of slow though certain decay before the bridge was quite finished, in the year 1770. I shall notice one more example, merely to show how completely this subject has been neglected heretofore, even by men of first-rate eminence. He whom we all admired for his abilities and munificence, who had risen to the most distinguished rank in his profession, whose perception and discernment in most things were more acute than in the generality of man,—the late Sir John Soane, about 20 or 25 years since, allowed the front of his own freehold residence in Lincoln's Inn Fields to be constructed with Portland stone of such an inferior quality, that it is already evidently mouldering away. It is probable that too much confidence was placed in the mason, who ought to have known better, and have acted differently.

Abundant examples of defective Portland stone might be pointed out; but when we consider that the stone brought from the island, good, bad, and indifferent, is all shipped from the same pier, which is a very small one, and that notwithstanding the blocks are marked in the quarry so as to denote from whence they were obtained, it is possible that some of them may be misplaced, we ought not to be surprised if occasionally a very bad stone is conspicuously placed in a building that is otherwise in excellent condition; and this we find more particularly to be the case in our modern structures, arising, no doubt, sometimes from ignorance or inattention, but often from some trifling interest, such as using a stone because it is just of the dimensions required.

These events seem to have brought about an important investigation, in which the reputation and interests of persons connected with architecture are deeply concerned. The Portland merchants had enjoyed the supply of stone to London and the south of England for an almost uninterrupted period of more than 200 years. I say almost, because in the year 1804 a duty of £26 8s. per cent. was

imposed on all stone conveyed by sea from one port of Great Britain to another. This was a temporary injury to the Portland trade, for large quantities of Bath stone were brought to London by canals, and consequently free of duty; but in 1823 the coast duty was taken off, and Portland again took the lead for all superior buildings. But its character was stained, and public confidence was lost, in consequence of a few individuals bringing ship loads of rubbishing stone into the markets, which was used by the unwary masons for all purposes. Many of our noblest structures, which were constructed with these defective materials, rapidly assumed the appearance of premature ruin; the architects and proprietors of buildings united in one universal cry against all kinds of Portland stone, and it has been condemned, without inquiring into the cause of complaint, as wholly unfit and unworthy of being used in substantial edifices.

To explain and illustrate the numerous qualities and localities of Portland stone would far exceed the usual limits of an essay. You will see by analysis, that the ingredients are apportioned in this stone much the same as in most other oolites; therefore its quality depends greatly upon the manner in which the component parts are united. There are not fewer than 50 or 60 quarries already opened at the Isle of Portland, most of them along the north-east and south-west cliffs, at an elevation of several hundred feet above the sea. The stone from each of these quarries, and from different beds in the same quarry, almost always presents some minute particularities, which, on very attentive examination, will serve to distinguish it from others. In many instances these distinctions are so conspicuous, as to be evident on the most casual inspection.

By minutely and attentively examining a specimen of Portland stone that is found, after 15 or 20 years' exposure to the weather, to be in a decomposing condition, its characteristic features will be on the whole lighter-coloured than such as is known to be good stone; arising partly from the entire mass being less crystalline, and from spots, veins, and rings of a lighter tint than the ground. The whitest parts are generally less cemented, and most friable; the stone is altogether of an open powdery texture; and the pores or vacuities being numerous compared with the bulk of solid matter, render it deficient in weight for its size.

(To be continued.)

ELECTRICITY—EFFECTS OF LIGHTNING.

TO THE EDITOR.

SIR,

In your Journal of last month, I observed a letter by Martyn J. Roberts, Esq., F.R.S.E., arraigning at the bar of facts and experience the mode of disruptive electric agency, which I attempted to establish in your October number.

Every reader of my letter will, I think, observe that I did not write with that degree of demonstrative evidence which compels assent, nor with that dogmatical confidence which doubts nothing. I am, therefore, quite unfettered by any opinions which I have yet advanced, if others appear more in accordance with the phenomena attendant on electric agency, as exhibited in the destruction of buildings. Nor should I further occupy your pages, if arguments of a conclusive character had been advanced in answer to my own.

First I must slightly modify Mr. R.'s statement of my opinion, "His principal position," says Mr. Roberts, "is, that the disruptive

effects of electricity are due *only* to its power of decomposing the materials through which it passes." My fundamental position is, that those *great* disruptive powers which electricity evinces in shattering masses of solid matter, are due to this species of power. Of the *lesser* electric forces, such as ordinary repulsion and attraction, I have said nothing; but I think they are probably the incipient state of the former. And it appears to be these minor repulsions that Mr. R. has virtually supposed capable to effect the most powerful agencies in nature.

The inventor of blasting by galvanism is fully aware that bodies positively or negatively electrified repel others in the same state with forces whose relative magnitudes are inversely as the squares of their distances. Hence his gold leaf so electrified will, by this power, "be scattered with great force in all directions." Gold being a dense body, its atoms must be in near contiguity, hence their great repulsive force; for each atom may be considered as an independent body, repelling every other. And further, the quantity of electricity which a body almost all surface can contain, is considerable, for it should be remembered that this is not as the mass, but as the extent of surface. There is, then, nothing in this but what might be expected from the ordinary repulsion of electricity, considering the mere film (a leaf) subjected to its influence.

Mr. R. states that many other similar instances might be adduced, and then infers that the choice of building materials is of no great moment as a protection from the effects of electrical discharges, an inference which, whether true or false, is certainly not warranted by the premises.

I now dismiss the negative part of Mr. R.'s letter, and come to the positive, which supposes the expansion of air contained in the interstices of bodies by electric action, to be the cause of its disruptive effects. In the case of the gold leaf, it is probable, if not certain, that there is no air in the metal. Air could not exist in copper, or iron, or any other oxidizable metal, without changing the interior, as it does the surface, into an oxide. Now, as the interiors of the metals present a clear metallic surface on fracture, it is evident they contain no air, and gold being more dense, and having less affinity for oxygen than either copper or iron, the scattering of the gold leaf could not result from this cause.

The quantity of air in granite, crystalline limestone, and all compact stones, must be exceedingly small, if indeed they contain any. The imperfect development of the crystalline forms, peculiar to each of their constituents, shows them to have been deposited or formed atom by atom, and the crystals to have been moulded upon each other. The quantity of water which permeates them appears small, and is confined chiefly to their surfaces, for it is here only that decomposition takes place. Now while these stones are so slowly permeable by water, for which one of the alkaline constituents of granite has so great an affinity, I conclude there is no reason for supposing they contain air sufficient to account for that irresistible force required to tear them to fragments by any expansive power that could be given to air. Now whether or not it be proved that the electric discharge shatters masses of one kind of matter containing air, I still conclude, in some cases from the entire absence of air, and in others from the minute quantity contained in bodies exploded by lightning, that the disruptive effect is due to some other cause.

In relation to the experiment on air in projecting a *light* ball, it is evident, from the rounded termination of the conductors, which

diffuse the electricity through a large extent of air, that the ordinary repulsion is given to its particles, as in the case of the gold leaf; but, as before remarked, this is quite inadequate to account for the destruction of buildings.

But the case is different with the decomposition of solid matter by electricity. The specific gravity of Portland stone is about 2050 times that of air; hence, when part of its constituents are rendered gaseous, they must expand with forces of great magnitude compared with that of air. And it must be also observed, that any decomposition of a stone in the track of the electric fluid destroys its cohesion, *the same matter which had before formed the bond of union furnishing now the expanding force.*

I have already intimated that I considered the repulsive force given to matter by electricity as an incipient stage towards liquefaction or decomposition, or towards the gaseous state, according as the essential properties of atoms fit them to exist in these states. In fact, I think it not improbable that every change of place or form in inorganic matter may be accounted for by the agency of electricity. For all displacements of the atoms or masses of matter from those with which they may be in contact, whether by ordinary motion or decomposition, develop electricity or disturb its statical state of equilibrium, and *vice versa*. The electricity so developed is in some substances positive, in others negative, and at different times both one and the other exist in the same body, owing to a slight change of temperature, or other circumstances. Hence we see why decompositions and combinations take place at certain temperatures by the development of electric repulsions or attractions in their atoms. Some Newtonian chemist may yet clear up this subject, by showing all motion of matter to have a common cause throughout the universe. For the squares of the distances of the great bodies which revolve in space may not be greater in relation to their masses than are the distances of the atoms which constitute the varied forms about us.

Having already transgressed the limits of this subject as adapted for your Journal, I cannot proceed farther. I will, however, observe, in conclusion, that from the limited and uncertain extent to which lightning conductors afford protection, they are far from ensuring perfect security. They would, however, certainly be improved by having that part of the rod above the building armed with projecting points, in three or four directions, at vertical distances of about a foot apart.

I am, Sir, your most obedient, &c.,
W. G.

[It will scarcely be necessary to assure our able correspondent, that our columns are most freely at his service for the full and perfect explanation of his views upon the whole of this important subject. It is only when a discussion becomes tame, trifling, or otherwise contemptible, that we feel any anxiety to draw it to a close.—Ed.]

PROFESSOR DONALDSON'S LECTURES AT UNIVERSITY COLLEGE, LONDON.

WE know not where the council of University College could have selected an architect more eloquent, more distinguished by attainments, or one who ranks as a more accomplished master of his profession, than the gentleman whose talents they have now secured for the Architectural Class of the College. We have before us Mr. Donaldson's Preliminary Discourse, pronounced at

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the University College on the 17th of October; and we have seldom seen a more glowing and spirited appeal to the intellect and the feelings, in favour of architectural pursuits. It is impossible that any one of those who listened to the eloquent Professor on this occasion could fail to have his ideas expanded and elevated by the rich and brilliant associations with which Mr. Donaldson invested his rapid glance at the progress and ancient history of architecture, while the observations which fell from him in reference to its state in our own times, and amongst modern nations, are not less sound and just than they are elegant and original.

Mr. Donaldson takes a broad and comprehensive view of architecture as the offspring of the most exalted sentiment of our nature—veneration for the Deity, and quotes the observation of Chateaubriand, "that architecture, considered as an art, is in its principle eminently religious: it was invented for the worship of the Deity, and those who had a multitude of gods were led to different kinds of edifices, according to the ideas which they entertained of the different powers of those gods."

Remembering how the progress of architecture is identified with the increasing political greatness of states—how the erection of magnificent temples and palaces, and public edifices of every kind, attests the national opulence, and the energy and wisdom of governments; how the accumulated wealth of many individuals expended in the execution of gigantic works nearly or remotely allied with commerce serves to mark the growth of freedom, the spirit of social confidence, and the paternal care of the ruling powers,—we are yet not to forget "how essentially architecture ministers to the simplest wants of man, as well as to his luxuries; how she contributes to the greatness of nations, by impressing foreigners with just ideas of their power, from the mere contemplation of their monuments; how important she is as handing down to the latest times the memory of splendid actions; inciting the citizens to noble deeds, and diffusing taste and elegance through every ramification of society, from the prince to the peasant, from the palace to the cottage. If, then," continues Mr. Donaldson, "the influence of the art be so important, what should be the qualities of mind required in her followers, and what the extent of his powers, who would render himself worthy of the art he professes?"

In his survey of ancient architecture, Mr. Donaldson draws a rapid, yet instructive and eloquent sketch of the remains of Greece, Rome, Egypt, and Syria. Descending to our own times, from the "majesty of the classic style," he pays an elegant tribute, each in its turn, "to the sublimity of the Gothic, the grace of the Revival, and the brilliant fancies of the Arabic."

Convinced that Mr. Donaldson, as a lecturer, is eminently qualified to command the attention of his pupils, to stimulate their studies, and advance them to a substantial knowledge of the profession, we have availed ourselves with great readiness of the admission which the Professor has been so good as to place at our disposal. In consequence of this, we are able to lay before our readers an abstract of the Architectural Lectures during the past month, and in continuing the course, as we hope to do, the instruction conveyed will, we doubt not, be found acceptable to all classes of our readers.

From a syllabus of these Lectures, which appeared with others as an advertisement in a recent number of the Journal, it will be seen that the Professor divides his Lectures into two parts—viz., into Course A., Architecture as a Fine Art, and Course B., Architecture as a Science. A lecture in each course is delivered every week—

namely, in Course A. on the Tuesday, and in Course B. on the Thursday.

The following abstract of the Lectures of Professor Donaldson are to be viewed merely in the light of notes, containing the gist of what appeared most useful and interesting.

These notes comprise the whole of the Lectures for the past month, but they are thrown together in succession, without regard to the divisions of the Lectures according to the actual days on which they were delivered. In order, however, to preserve the distinction between the two branches into which the Lectures are divided, we have placed consecutively all the notes relating to Architecture as a Science under one head, and those relating to Architecture as a Fine Art under the other; although, as before observed, the Lectures are devoted alternately to each of these branches.

Course A.

ARCHITECTURE AS A FINE ART.

Ionic Order.—The Professor, after some preliminary remarks on the Doric order, which had been considered in a former lecture, proceeded to describe the Ionic order. The earliest examples appear to have been in Ionia in Asia Minor, where it was most probably invented, and whence it derived its name. The Ionic of Athens, as in the Acropolis, is more enriched than that of Ionia, but the latter possesses more simplicity. As in the Doric the triglyph and capital are the peculiar marks, so in the Ionic, its volutes distinguish it. The Professor, after describing most minutely the different changes which the Greek mouldings had undergone, stated that a great difference existed in their outline. The profile of the Grecian would generally assimilate to a straight line, whereas that of the Romans showed much greater projection, the ornaments and mouldings being much more in relief. The Romans thought the Grecian mouldings very stiff, and therefore made a variation. The Ionic order has both an Ionic and an Attic base; the former is peculiar to itself, and the latter has also been adopted in the Corinthian order; the height of the column in the Ionic order is from $8\frac{1}{2}$ to $9\frac{1}{4}$ diameters, but in the Temple of Didymæus, which is a solitary example, it was as much as 10 diameters high.

The proportions are of course to be regulated by the size and the number of columns; thus the proportions of a four or six column portico should be very different from one of ten columns (as in the temple of Apollo Didymæus). The Professor, after giving the proportions of the base, according to Vitruvius, proceeded to describe the parts which constituted it. The lower torus was not always made a segment of a circle, as in some examples it projected most at its top, whilst in others it projected most from the bottom. The Professor here pointed out an error which had been committed in one of the publications of the Dilettanti Society; it was in the plate showing an Ionic base; the scotia, &c. had been represented as being of less diameter than the shaft of the column. This, however, was corrected in later editions of the work. Errors of a similar nature had crept into Stuart's Athens, where many of the details of the mouldings had been incorrectly represented.

The shaft of the Ionic column differs from the Doric in the number of its channellings or flutings, the Doric generally having only 20, whereas the Ionic, in most examples, has 24. They also differ in the shape of their channellings, those of the Doric being very flat, whereas those of the Ionic are deep, nearly semi-elliptical, and are divided from each other by a broad fillet,

which gives great character. The terminations of the flutings are semicircular; in which they also differ from the Doric, which are made in a flat elliptical form. The diminution of the column varies very much in different examples.

The Professor then proceeded to describe the capital, which was considered the most important part of the Ionic order. Its distinguishing features are its volutes, which, when large, give to it great dignity. The French dislike large volutes, and the consequence is, that their Ionic order is marked by great meanness.

The Professor here described the methods of Palladio, Goldman, and others, for drawing volutes, and showed one which he had himself contrived, and which he had found most convenient in practice.*

After pointing out by means of drawings from the best examples, the different shapes of the bolster which connected the volutes, and also the ornaments most commonly attached to it, the Professor proceeded to describe the angular volute, which has been introduced in the ancient examples, in order that the end column should correspond with the side one. This did not appear to him at all satisfactory, nor did he think there was an absolute necessity for such a deviation. It appeared to have been followed because architects were afraid to make an alteration from the ancients. The Professor recommends any of his class who should at any time have occasion to erect an Ionic portico, to try the effect which would be produced by placing the columns with all their faces outwards. The *antæ* were next referred to: these are the projecting ends of the temple. The *antæ* has no reference to the column, it has always had a base of the Ionic order, and rather diminished towards the top. In the examples of Asia Minor, the capital approached nearer to the height of the capital of the columns. The entablature is divided into the architrave, the frieze, and the cornice. The whole entablature is one quarter the height of the column, and the architrave is equal to three-fourths of the lower diameter of the column.

The following are the principal differences between the Doric and Ionic orders. The invention of the Ionic order was subsequent to that of the Doric. The Doric shaft varies from $4\frac{1}{2}$ to $5\frac{1}{2}$, and sometimes to 6 diameters. The Ionic varies from 8 to 84. The flutings on the Doric shaft amount to 20, and are separated by a mere arris, whereas the Ionic is frequently plain; but when fluted, it contains 24, which are divided from each other by a plain fillet. The capital of the Doric has merely an echinus and lofty abacus; the Ionic has volutes and small mouldings, very richly carved. The Doric architrave presents one broad fascia; the Ionic has two, and sometimes three. The soffit of the Doric is plain, but that of the Ionic is enriched. The frieze of the Doric is composed of the triglyph and metopes; the Ionic is only enriched with sculpture. The Ionic has always a bead moulding, and mostly a dentil band.

The entablature of the Doric is about one-third of the height of the column; in the Ionic it is only one-fourth. The *antæ* in the Doric are small in proportion to the size of the column, but in the Ionic they are large. The *antæ* in the Doric are generally pointed, but in the Ionic mostly curved: in the Doric they are without much variety, but in the Ionic a very great variety exists.

* We are obliged to omit this description, as it could not be understood without the aid of diagrams.

The Doric is sometimes on steps, but never on a pedestal, but the Ionic is sometimes on a pedestal.

The best examples of the Ionic order in the metropolis are, St. Pancras church; the church in North Audley Street; the Post Office; Hanover Chapel, Regent Street; Law Institution, Chancery Lane; East India House; entrance arches in Hyde Park; and the church in Eaton Square.

In the temple of Apollo Didymæus the architrave is divided into two fasciæ, but in other examples it has three. The architrave is also surrounded with mouldings equal to one-seventh of the general proportion of the architrave. The soffit of the Doric is plain, but in the Ionic it has a very beautiful moulding, as in the temple of Apollo Didymæus. The panel is a plane face, and in order to give it more relief, it was frequently enriched with dark marble; when enriched, the height was generally made greater. Vitruvius gives the height as one-fourth less than the architrave. Simplicity always gives it the effect of looking larger than it really is. The architrave and frieze, when of the same height, are in good proportion.

Corinthian Order.—This order, which is still more ornamented than the Ionic, is supposed to have taken its proportions from the figure of a virgin: it is more delicate and more ornamented than the Doric or Ionic orders. The earliest and only real Grecian example is the Lantern of Demosthenes (Choragic Monument of Lysicrates). The capital is the distinctive feature; its column and entablature are divided in the same way as in the Ionic order. The height of the base is about half a diameter of the column. The base of this order is that known as the Attic base, which, as before observed, is also common to the Ionic order; it may be used either with or without a plinth. The column is generally stated to be ten diameters high; this, however, is not perfectly correct; in the Greek examples they are all under ten diameters, but in the temple of Jupiter at Rome, and in a few Roman examples, it is ten diameters. Where a dignified appearance is sought, the height should never be so great as this. The shaft may be either plain or fluted; it must necessarily be plain, however, when composed of hard stone or marble, as in the Pantheon, where the columns are 38 feet 9 inches high, and are formed of one piece of granite; the expense of fluting would, under these circumstances, be very great. In the interior of the Pantheon the columns are fluted; they are composed of Sienna marble, the bases and capitals being of white marble. The number of flutings in this order is twenty-four, and they are generally semicircular. The shaft diminishes towards the top. The following proportions are given by Vitruvius:—

When the column is 15 feet high, the diminution at each side should be	2-12ths of the diameter.
When from 15 to 20 feet high	2-13ths "
" 20 to 30	2-14ths "
" 30 to 40	2-15ths "
" 40 to 50	2-16ths "

The examples, however, do not always follow this rule; indeed, the diminution should be made according to the place in which you stand to view a building; for instance, a difference should be observed according as you view it from a distance or from an adjoining street. If you require a substantial building, there ought to be little diminution in the columns; but gracefulness can only be produced by great diminution. The Greeks abhorred a straight

line; the contour of the shaft of their columns was therefore made to form a curve. Many authors differ with respect to this curve, some being of opinion that one-third of the shaft was perfectly cylindrical, and that only the other two-thirds were made to diminish.

The capital most likely derived its origin from the story related by Vitruvius, of a basket having been placed on the tomb of a Grecian lady with some flowers in it, and a tile on the top to protect them. An acanthus growing round a basket, with its tendrils springing forth, and forming the cauliculi, might have given Callimachus the first idea.

Course B.

ARCHITECTURE AS A SCIENCE.

In former lectures the Professor had commenced some account of the different kinds of timber suitable for architectural purposes, and the attention of his pupils is now first directed to the subject of mahogany. This timber is generally imported into Great Britain from the East and West Indies, and from North America. These countries produce trees of enormous size. The exact time which this timber requires to arrive at perfection does not appear to be accurately known, but it may be considered as not less than about 200 years. The great price of mahogany prevents its being used by the builder; it is therefore only employed for decorative purposes. To show the value of this timber, a log had been sent to Liverpool weighing no less than seven tons; it was first sold at £200, again sold for £500, and it was most likely not worth less than £1,000. This timber does not flourish in moist soils, as it is then found to contain sap-wood. The colour of mahogany may be greatly reduced by the application of an alkali. Mahogany should not be used near marble work, as it is apt to stain the marble, should the mahogany be washed. The East Indies produce mahogany of large size, and of very durable quality.

Amongst the timbers applicable to building purposes, that of oak is particularly suitable for carpentry, both as regards its size, strength, and compactness of fibre. It can be procured from 60 to 80 feet long, by 2 feet square. It is a maxim commonly received, that the oak requires 100 years to grow, 100 to maintain itself, and 100 to decay. It is supposed, however, to last much longer than this period; and under favourable circumstances it has been known to last for 500 or 600 years.

The Professor here produced a piece of oak from one of the piles of old London bridge. The specimen was remarkable for its great weight and soundness. The density of oak is in proportion to the length of time it has been growing, and the heaviest is always the strongest. It is heavier at the bottom of the tree than in the middle, and in the middle it weighs more than at the branches, or at the top. The heart of oak is the hardest when the timber is sound, but as it falls into decay the heart becomes softer than the circumference. The weight of a cubic foot is from 70 to 74 lbs.; it loses weight in drying in the following proportions: when reduced in weight to 60 or 63, it may be said to be half dry; when from 50 to 53, quite dry. The fibre of wood loses much of its tenacity by drying; that is, it can be more readily split in the dry state. It can be used to the greatest advantage by the carpenter when it weighs about 60 or 63 lbs.

Fir is lighter, more elastic, and easier worked than oak.

Ash is a bad timber for the builder's use, as it stands neither moisture nor dryness.

Beech is a bad timber when wholly under water; but elm is found to stand well when entirely immersed in water.

Birch is very tough, but liable to decay from moisture.

The great sources of the supply of fir to this country are the North of Europe and North America. Riga was formerly the port from which all log-timber was supplied; and from 1757 to 1778 $\frac{1}{10}$ ths of the 12-inch square timber came from Riga. The timber of Riga in joists and girders is particularly clear in the grain, but it is liable to be shaken in the joints. Next to Riga our best supply of timber comes from Dantzic. The timber from this place is of great durability, and of large size, it being possible to procure it of 14, 15, and even 16 inches square, by 70 feet in length. The best fir timber is full of turpentine.

The timbers which we import from our possessions in America are generally the red pine and yellow pine, to which may be added the pitch pine, which has been brought from the United States, through Halifax, in order to save the duty. The red pine, if a regular square, would sell at the same price as Riga timber, but is from 15 to 20 per cent. cheaper, in consequence of its tapering towards the top. Red pine, exclusive of Upper Canada, is brought in great rafts to Quebec, in order to avoid the duty. Government, however, when considering this subject, have not put a check to its importation, in consequence of the great number of persons employed in bringing it down the St. Lawrence. There is seldom a cargo of timber which does not exhibit some signs of dry-rot; and should the voyage be a long one, it is almost sure to have the fungus deeply embedded. A risk is therefore incurred in using this timber unless a close examination be made, or unless Kyan's patent, or some other mineral poison, be used to check its ravages. It is very dangerous to use this timber in fresh brickwork, because under these circumstances it is almost sure to be attacked by dry-rot, and is therefore unfit for girders. The Professor related an instance of its use in a building contrary to the architect's wishes, and added, that the dry-rot had made such ravages in the short space of four years, that it had been necessary to replace the whole of the timber-work. Yellow pine, for the English market, is supplied in large quantities from St. John's, Quebec, and several other ports; it is unfit for girders, nor should it ever be used when rigidity is required, as it breaks with a less strain than any other timber, and is exceedingly liable to the dry-rot.

Deals, in order to be good for the joiner's purpose, should have a certain degree of softness and mellowness, and should exhibit a silky texture when planed.

Deals have been cut at different times in various ways: the present English mode is to cut the log into four deals, two of them English deals, 3 inches in thickness, and the other two French deals, $1\frac{1}{4}$ inches thick. The old method of cutting was to take two $2\frac{1}{4}$ inch English deals out of the centre of the log, and two $2\frac{1}{4}$ inch battens from the sides of these, the battens being not so wide as the deals. The advantage of the present mode is, that the deals contain more of the heart of the wood, and less of the sap-wood, than when the old process was employed.

The yellow deals of Christiania are both durable and mellow, and when properly seasoned, retain their shape. The duty has latterly caused this timber to be shipped of great length, but of small girth, in order to avoid extra duty. It is worthy of remark, that most of the ports from which we derive timber, are situated near the mouths of rivers. These are of vast importance, as affording the means of transporting wood through a great extent of country.

Professor Playfair had described a very ingenious plan which had been adopted for bringing timber down from a mountainous country, where there was no conveyance by water. This was effected by fastening a number of balks of wood together, in the form of a large trough, which had sometimes been made of a length of 6 or 7 miles, that is, sufficient to reach from the high country, where the timber is felled, to some low spot, whence it can be conveyed by other means. The timber, as it is cut down, is placed in this trough, and made to slide down from the top to the bottom; a small mountain stream where practicable being turned into it to prevent fire from friction. It is advisable if possible to avoid all obstructions, as the balks, in sliding down, acquire such velocity as to carry everything before them.

The timber which is imported from Stockholm, is frequently of 100 feet in length, but in order to avoid the duty, it is shipped of inferior size. It is not so mellow as that of Christiania, or it would be preferred. The yellow deals of Gottenburg are not well adapted for fine joiners' work. The Archangel deals are not well adapted for floors at the bottom of a house, nor should they be used in damp situations. The Petersburg deals are very liable to dry-rot. Memel supplies large quantities of plank; that used by brewers is chiefly from this place, and the Memel timber is also applicable to steps and stairs; Dantzic affords timber for decks of ships. The yellow deals from Finland are 14 feet long; the lowland white deals have most of the bad qualities of the American spruce. Battens are deals of 7 inches wide; they are used for floors, window frames, &c., and, on account of their cheapness, are often used in small houses. The American deals are of three descriptions: the best quality is shipped from the St. Lawrence. American deals should be used when perfectly dry. The yellow pine, when shipped wet, gets covered with a fine net-work, which is the commencement of the dry-rot: if floated down the river, the rot sometimes attacks it so much, that the deals are obliged to be separated by force. On being discovered, the best way of preserving them is to pile them on their edges, as they will thus permit the air to pass more freely. The Professor strongly recommended those of his hearers who had any spare time, to walk occasionally in the vicinity of the docks, where timber was constantly being unloaded, and there examine the state in which it arrived; the young architect would in this way gain a vast deal of useful information connected with the liability of timber to dry rot, and would learn to distinguish those which were most likely to be attacked during a long and wet voyage.

Amongst the publications which might be consulted with advantage on the subject of timber, was Hill's work on timber trees; and there is also a most valuable little treatise published by the Society for the Diffusion of Useful Knowledge. The Parliamentary Reports might also be referred to with great advantage. It is important to have a clear idea of what is called the neutral axis, because the strength of a beam greatly depends upon the position of the imaginary line so called. When a weight is placed on a beam, the fibres in the lower part of it are subject to extension, and those in the upper part are subject to compression. The line which separates the compressed part from the extended part is called the neutral axis. With regard to the situation of the neutral axis in rectangular beams, it is about 5-8ths from the bottom, if supported at one end, and 5-3ths from the top when supported at both ends.

Timber is said to be affected by the atmosphere, also by the

ligneous fibre, by the age of the tree, and the quantity of sap. All matter between the concentric layers of which the trunk is composed, is much softer than the layers themselves. The two principal qualities of wood in point of strength are, first, its resistance to tension, that is, the force which tends to stretch or extend; and secondly, its resistance to compression. In constructions, it is not of so much importance to ascertain the force which would break a beam, as it is to determine that force which would give it a cast, and prevent it from returning to its original form. A weight capable of breaking a beam may frequently not do so at first; and there have been instances, in churches and other buildings, where beams have supported for some time a weight which has at length broken them. The fibres are thus, in time, gradually dislocated. In all constructions, decay should be as much as possible avoided, and particularly that from every kind of rot. There are three ways in which a piece of timber may be subjected to a strain: first, the weight may be placed perpendicular to the fibre of the beam, as in a rafter, joist, or girder, so that the fibres of the convex side will be extended, whilst those on the concave side of the beam will be compressed, and thus a fracture will ensue from too great extension or compression. Secondly, a force may act in the plane of the length, so as to shorten or compress its fibres, as in pillow posts and braces. Thirdly, an effort may be made in the direction of the fibre, to tear asunder a beam of timber, as seen in the case of king and queen posts, tie-beams, &c., where the timber can only give way by its fibres tearing asunder. Suppose one end of a beam to be fixed in a wall, and a weight placed at the other end, the beam would break with a comparatively small load. Suppose, in this case, it supported a ton; then let weights be distributed all over the beam, and it will then be found to bear a weight of two tons. Next suppose a piece of timber supported at both ends, and let the greatest weight it will bear in the middle of the beam be 20 cwt.; here also it will be found that the beam will support two tons, that is, a double weight, if it be loaded uniformly over its whole length. Again, suppose that a beam placed between two supports, with its ends fixed, will bear a weight of 30 cwt. in the middle; the same beam will bear 60 cwt. uniformly distributed over it. The Professor here pointed out the experiments of Belidor, Tredgold, and other eminent authorities, on the strength of beams of different dimensions, from valuable tables which he had drawn out for the purpose, after which he proceeded to try experiments on the weights necessary to break timber of different dimensions. The experiments agreed very closely with those of Belidor.

A piece of timber will not be at all affected by cutting it on its compressed side as far as the neutral axis; and by filling up the saw cut with a piece of hard wood, the beam will be actually strengthened. The strength of timber is inversely as the length—that is, if a piece of timber be twice as long as another piece of the same depth and width, it will bear but half the weight. The strength of timber cut from different parts of a tree varies very much; thus a piece cut from that side of a tree which, when growing, was towards the north, will not be as strong as a similar piece cut from the south side. On this subject very extensive experiments were made by Buffon and Duhamel, who were employed by the Government for this purpose. In their experiments the beam, when loaded, was allowed a considerable time to break, as it is not considered a fair experiment to load it too quickly, the beam often breaking, after a little time, with a load which at first was insufficient.

The state of the atmosphere is found to affect timber very much, as it is found to be tough when the weather is humid, and on the contrary, if the weather be very dry, timber becomes brittle. The Professor here tried a number of interesting experiments on oak and fir. He then proceeded to explain the formulæ for calculating the strength of beams of different sizes; the constant which is introduced in these formulæ is the mean result of a number of experiments made on a cubic inch of timber. The constant of fir has been taken at 1108 lbs. Suppose, for example, we take a piece of fir, 6 inches deep, 4 inches broad, and 5 feet long, the law is this:—

$$\frac{\text{Constant} \times \text{breadth} \times \text{depth}^2}{\text{Length}}$$

equals the weight where the breadth, depth, and length are all in inches. The result here is the extreme weight which a beam would bear. Rondelet takes one-tenth of the sum, as the weight which a beam should in practice be subjected to, but Tredgold says a fourth. In this example, the beam is supposed to be loaded at one end, and fixed at the other. It has been before shown that it will bear twice as much, if the load be distributed; it is therefore only necessary to double the result of the last formula. We now take a beam with both ends supported, but not fixed, and the load acting in the centre; the rule is thus:—

$$\frac{\text{Constant} \times \text{breadth} \times 4 \times \text{depth}^2}{\text{Length}} = w \text{ in lbs. avoirdupois.}$$

The various experiments which the Professor tried on timber were intended more to show the mode which ought to be adopted in testing its strength, than to establish data for practical purposes. The Professor then gave formulæ for calculating the strength of timber subjected to a strain in the direction of the fibres.

In calculating the cohesive strength of timber, it is only necessary, after the constant has been ascertained, to multiply its sectional area by this constant, as the length does not affect a piece of timber when the weight is suspended in the direction of its fibre.

THE NEW HOUSES OF PARLIAMENT.

In accompanying Professor Hosking, of King's College, and his architectural class, over the works of this building, we were much pleased with the easy, familiar, and practical style in which the Professor conveyed instruction to his pupils by actually examining and pointing out the uses, adaptations, and connections of the materials and implements used in the practice of building.

The real examination of works by a class of youth under the guidance of a judicious and practical instructor is exceedingly useful, as it serves to vary the dryness of abstract study, and to throw a spirit of life and interest into the labours of the student. Amongst the more interesting expedients which were pointed out to the attention of the class, and commented on by the Professor, we may mention the following as examples:—The employment of hoop-iron in place of wood for the attainment of effectual bond and connection of the brickwork. In the foundations of the great Victoria Tower at the south end of the building, the hoop-iron was employed at two different levels, one near the base of the brickwork, and again at the surface of the ground. In the latter situation

the ends of the hooping are at present exposed. They appear to be laid in long strips at about three inches apart, and to extend over a great area, throughout the whole of which they are placed between the same two courses of brickwork. Mr. Hosking explained the mode in which they served to counteract the effect of settlement in the brickwork, and pointed out that while they were equally effective with wooden beams, they possessed over the latter the advantage of being fire-proof. The strips of iron before being used are tarred and sanded, in order to increase the cohesion. A simple contrivance, consisting of an endless chain worked by a crab, was pointed out for raising hods of mortar and bricks to the top of the building, to avoid the incessant climbing of the workmen up the ladders. It was stated, however, that the apparatus was not approved on the works, probably because the motion was slow and the friction great. The machine has been patented by a Mr. Spurgins. At a place where concrete was being placed in the foundation the workmen were observed mixing the quick-lime with gravel, and carrying it off in barrows before mixing it up with water. It was stated that on being thrown into the foundation it was there mixed with the water, and immediately formed into concrete. A metallic sand from Swansea is used in making the concrete.

We next ascended several ladders to the top of the wall, and there an excellent contrivance was pointed out for producing a kind of joggle between each adjacent pair of stones, when these are of small size and are not set on their broadest bed. At the joint a vertical niche of a triangular shape is made in each stone, so that when they come together the two niches form a hollow prism, with a lozenge or diamond-shaped base of about three-quarters of an inch; into this a few hard angular pebbles are loosely dropt one upon another, and the interstices filled in with some fluid cement; the effect of these pebbles acting as a joggle will be readily seen. We observed no timber being used for joists in any part of the building, in place of which iron girders are bedded upon stone set in the brickwork. The Professor pointed out the method in which these assist to prevent bulging out of the walls, and showed how the woodwork of the flooring was connected with the iron-work. The mullions of the windows are secured to each other by joggles of slate, one of which was brought to the Professor for inspection; it was two inches long by an inch square, and it was stated that some of the joggles used were as large as eight inches in length, with an area of four square inches. The varieties of stone were briefly alluded to. The magnesian limestone from Anstone, Bolsover, and other places in the neighbourhood, is used for the great mass of the work, and for some of the outside ornamental work. The inside ornamental work is chiefly of the Bath stone from the Painswick quarries, and it was stated that a limestone from Steetly has also been a good deal used for some of this kind of work.

The contractors, Messrs. Grissell and Peto, are now engaged in their fifth contract at these works. The foundations of the great central tower are completed. It will be remembered that this is the tower recommended by Dr. Reid for carrying off the whole of the foul air, and the products of combustion, from all the fireplaces in the building; it is therefore sometimes called the ventilating tower. The fresh air for ventilating the building will be taken in at the top of the Victoria Tower at the south, and the clock-tower at the north end of the building.

BORING TOOLS USED FOR THE ARTESIAN WELL AT GRENELLE.

THE boring rods are of wrought-iron, screwed to each other in lengths, according to the depth of the boring; at the end of these rods various instruments are fixed, suitable for piercing the different strata: for the soft ones, the auger, shown by fig. 1, is sufficient. Running sand, or any fluid material, is brought up by a hollow cylinder, the valve of which opens and shuts by means of a moveable globe (fig. 2). A hard rock is laboriously perforated by the aid of a jumper with three cutting edges (fig. 3). To prevent the earth falling into the hole, it is cased with metal tubes screwed into each other. Any one of these tubes may be drawn out at pleasure, and replaced by another of greater diameter, by means of the instrument (fig. 4), which is screwed into the thread cut in the interior of the tube.

Fig. 5 is an instrument for drawing up the boring-rods, when by any accident one of them becomes broken, or fixed in the perforation during the process of boring.

ARCHITECTURAL COMPETITION.

PROFESSOR HOSKING'S Introductory Lecture at King's College has just been published, with some valuable additional remarks on competition, from which we take the following extracts:—

English architects will not require a recital of the insults and injuries which the system of competition is constantly inflicting upon them, and the periodical publications which take notice of such matters teem with the complaints of individuals of the particular injustice suffered by themselves, whilst a sort of idiotic folly seems to render the complainers insensible, that in accepting insolent proposals they embrace insult, and must submit to injury. The writer of this notice came to the conviction of the viciousness of the system after experience had taught him that it was not capable of being pursued successfully with honour; and, having acquired the conviction, he urges it upon his brethren as one from which they cannot escape, if they would retain a consciousness that their profession deserves to be considered liberal, and if they desire to be esteemed as gentlemen. It is an unworthy excuse for continuing the unworthy practice that some will still pursue it, and secure all the commissions. There are pettifoggers in all professions; but let the public once perceive that none but pettifoggers in architecture apply for the premiums offered to tempt the simple, and as none but the simple apply to the quack, so all but the silly would cease to seek the aid of the gratuitous Competitor.

Having himself ceased to take part in so-called competitions long before the state of his practice would justify him in the abandonment of any honourable mode of obtaining business, and, as before stated, upon a sincere conviction of the innate badness of the system, and of the injury done by it to the profession, to the public, and to the science of architecture itself, the writer has not hesitated to denounce the system, with the hope of arousing others to join in advocating—not a reform, for a vice cannot be made better, but—a total abandonment of the wretched game.

The public ought to understand, that what is generally required in a competition *cannot* be fully and honestly complied with by either party. It is one thing to make a design for a building of the kind and capacity required,—it is another to arrange such design in detail, that the cost of executing it may be accurately estimated,—it is still another thing to specify particularly all the materials, and their various kinds, qualities, and capacities, the operations to which the materials shall be subjected, and the quantity and quality of the labour or workmanship that shall be bestowed upon them respectively,—and it is still a further operation to estimate from the detailed drawings and particularized specifications what the cost of the building must be. All these things should be done, nevertheless, and by every competitor, when the cost is a condition; and, moreover, every design so elaborated should be fully investigated in all its details, or the conditions of the competition are not fulfilled by the parties imposing them. Now, conscientious men, having entered upon a competition, are compelled to limit the extent and appearance of their design to the means set forth in the "conditions," and to satisfy their

own minds that it can be carried out, as the parties requiring it expect, within those means. The most conscientious, however, cannot do all that ought to be done to make the conditions complete,—*cannot*, because of the immense disproportion between the labour and expense which such fulfilment would involve, and the probability that the labour and expense so applied will be of the slightest value. But the practice has been, and is, and always will be, with bodies of men, be they small or large, committees or the public in general, to look at externals—at the mere outside; and they are influenced by the effect produced in or by the prettiness of the drawings or models in which the design presents itself; the merits or demerits of the "plan," as architects understand the term,—the kinds and qualities of materials and workmanship,—the extent of enrichment in detail,—and the thousand other things that go to affect the merit of a design, and its compliance or non-compliance with the "conditions," are neither attended to nor understood; the effect of the design as to its decorative disposition is the utmost that they perceive, and the decision takes place accordingly. Hence it is that the conscientious man must always be an unsuccessful public competitor when cost is a condition. Even in the notorious case of the Royal Exchange, which might appear to contradict this, the reputedly successful conscientious competitor was still, for any value attachable to success, unsuccessful.

There are many things again in which the unscrupulous may gain the advantage when detail is required, and cost is a condition. The terms "timber," "stone," and "brick," represent materials of widely differing qualities; and their application in a building may involve widely differing quantities; while the quantity and quality of workmanship, and the various accessorial matters, may differ even more greatly than in the materials themselves. For instance,—Is the drainage of the site and of the building provided for? Does "moulded" mean that a particular piece of work shall have expended upon it *fifty or a hundred feet of moulding*? Are the joints to be "joggled" or "plugged"? Are they to be "cramped," and, if so, with iron or with copper? Is the mortar to be of road-drift, washed or unwashed, or of river-sand, screened or unscreened? Is a capital or a finial to be carved in such a manner that a carver shall be employed a week or a fortnight in doing the work? and shall he be a man worth thirty shillings or three pounds a-week?

These are matters of which the public, as such, and committees of public or of private bodies, *can and do* know nothing; but these, and an infinite number of others, enter into the question, and are essential to the full and honest investigation of the merits and demerits of various designs for the same building under the same conditions.

In truth, the public or their committees ask for *too much*, having reference to what they *really want*. Let the requirement be confined to a general design of a building of the particular kind required,—of certain capacity,—and adapted to a particular site, and to be built of certain main constituent materials. Stipulate for a particular scale, and that the designs shall be presented in drawings, in outline or tinted, and of what particular tint or tints alone; and, if perspective views are desired, fix the point or points of view. More will not then be required than most architects would be willing to engage themselves upon for a comparatively small fee, giving the public thereby the advantage of competition, as far as it can be made of any use, without involving the great expense that elaborated designs must occasion. The one, two, and three hundred pound premiums now held out to gambling crowds might then be divided into twenty, thirty, forty or fifty guinea fees, according to the circumstances of the case, and offered to such practitioners as might be known, or whose latent "talent" committees or individual members of committees might desire to draw out or encourage; and as no man educated to a liberal profession is without some connections to whom it will happen to be able to give a helping hand, by nominating him, or procuring him to be nominated upon one such competition or other, all "talent" *connected with knowledge and supported by character* might emerge from the greatest obscurity in which it is to be found *so associated*. The successful competitor under such circumstances might be trusted to carry out his design in detail, adapting it to all the circumstances of the case much better than he could have done in a general competition.

In an endeavour to convince architects, as a profession, in what their true interest consists, it is perhaps but proper to have pointed out to the public that the present system of competition represses the honourable candidate for reputation and employment, by rendering it impossible for him to compete on equal terms with the unscrupulous, and that consequently the public are thrown into the hands of the latter; and to have pointed out also that there is a reasonable course that may be pursued, by which all the advantages of competition are to be obtained, although architects refuse any longer to lend themselves to gambling speculations.

The public will, nevertheless, go on as they have gone on, until architects, as a profession, shall have declined any longer to degrade and beggar themselves. It is, therefore, not a question proposed to the public,—and it is one indeed with which the public have nothing to do,

beyond the interest which the public have in raising the character of the profession of architecture, but which they will never recognise while they think they benefit by its debasement. *It is a matter to be determined by the architects themselves*; and it may perhaps be hoped that this exposition of the abuse the profession labours under will induce all who are not quite besotted with the vice to consider the question in this its true point of view; and, having so considered it, there can be, it may be further hoped, no doubt that all those who have any sense of honour and virtue, or, indeed, any self-respect remaining, will no longer lend themselves to the present degrading system, and it will soon cease to exist among us.

ON THE HYDRAULIC AND OTHER WORKS OF THE ANCIENT PERUVIANS.

(From *Ewbank on Hydraulic and other Machines*.)

MOLINA, in his 'Natural and Civil History of Chili,' observes, that previous to the invasion of the Spaniards, the natives practised artificial irrigation, by conveying water from the higher grounds in canals to their fields. Henera says many of the vales were exceeding populous, and well cultivated, 'having trenches of water.' The Peruvians carried the system to a great extent. "How must we admire (says Humboldt) the industry and activity displayed by the ancient Mexicans and Peruvians in the irrigation of arid lands. In the maritime parts of Peru I have seen the remains of walls, along which water was conducted for a space of from 5 to 6,000 metres, from the foot of the Cordilleras to the coast. The conquerors of the 16th century destroyed these aqueducts, and that part of Peru has become like Persia—a desert, destitute of vegetation. Such is the civilization carried by the Europeans among a people whom they were pleased to call barbarous." These people had laws for the protection of water very similar to those of Greece, Rome, Egypt, and all the older nations; for those who conveyed water from the canals to their own land before their turn, were liable to arbitrary punishment. Several of the ancient American customs respecting water, were identical with those of the oldest nations;—they buried vessels of water with the dead. The Mexicans worshipped it. The Peruvians sacrificed to rivers and fountains. The Mexicans had *Kaloc* their god of water;—holy water was kept in their temples: they practised divination by water. The Peruvians drew their drinking water from deep wells; and for irrigation, in times of drought, they drew it from pools, and lakes, and rivers.

The annals of the world do not furnish brighter examples of benevolence than the early history of Peru. The wars of the incas were neither designed nor carried on to gratify ambition or the lust of conquest, but to extend to the brutalized people by whom they were surrounded the advantages of civilized life; to introduce agriculture, and all its attending blessings, among hordes of savages that were sunk in the lowest depths of bestiality. But that which sheds a peculiar glory over the ancient Peruvians, was their systematic and persevering efforts to achieve their conquests without the effusion of blood. In reading their history, the mind is not only relieved from those horrible details of carnage that constitute so prominent a part in the historic pages of other nations; but the most agreeable emotions are excited by the benevolent, and generally successful, endeavours of this people to overcome their foes by reason, by exhibiting to them the advantages of regulated society, and by invitations to embrace them. This policy was in accordance with the injunctions of their first king, whose precepts they generally revered. He taught them to overcome their enemies "by love—by the force of benefits;" and hence we find, that when they were successful they neither robbed the inhabitants of their land, their liberty, nor their lives; but used their influence and superior knowledge to ameliorate their condition. And when these efforts failed, and active warfare was the only resource, they, conscious of the wickedness of conquering men, by their destruction, and that those could never be good subjects who 'obeyed from fear,' uniformly besieged them, till the latter became convinced of their own inability to resist, and of the policy of acceding to the terms of their powerful invaders.

In this manner the 'children of the Sun' extended their conquests over a large part of the southern continent; and in no part of the world were provinces more loyal, or a people more attached to their institutions and to their princes, nor was there ever a people more humane. The conduct of some of the incas, when at the head of their armies, in enduring the taunts and scoffs of their ignorant and imbecile foes with philosophic forbearance, is truly admirable, and might be contrasted with that of christian warriors; especially their object was not to acquire fame by the destruction of their species, but to benefit them, even at the risk of their reputation. If ever offensive wars were justifiable, those of the early Incas

were, since their object was the extension of human happiness, and which they carried on in a corresponding spirit of humanity. In neither sacred nor profane history can such examples be found. Agriculture was the first object to which their attention was directed; hence we find engineers, and other artists, immediately sent into the subdued countries, or rather among their new friends, to introduce the arts of ploughing and cultivating the soil, &c.; and as large tracts of land were destitute of vegetation for want of water, mention is constantly made of aqueducts and reservoirs amongst the earliest works undertaken. In some districts rain was, and still is unknown. "For the space of 700 leagues along the coast (says Garcilasso) it did never rain." Contrivances to obtain and distribute water were therefore with the incas, as with the early kings of Egypt, the most important and constant objects of their care. Nor does it appear that the Egyptians were more assiduous in this kind of labour than the people of Peru. Examples are mentioned of the latter having conveyed small streams through a space of 60 miles, to irrigate a few acres of land.

There are several points of resemblance between these two people, some of which are to be attributed to both countries being, in a great measure, destitute of rain. The first inca, like Osiris, taught the inhabitants to cultivate their land, to construct reservoirs and aqueducts, to make ploughs, harrows, and shoes for their own feet; such shoes, says Garcilasso, 'as they now wear.' The wife of Manco Capac, like Isis, taught the women to spin, to weave, and to make their own garments. Some of their fables, too, resemble those of the Egyptians respecting Isis. According to one, "the maker of all things placed in heaven a virgin, the daughter of a king, holding a bucket of water in her hand, for the refreshment of the earth." Both people erected stupendous structures and statues of cut and polished stone, which they wrought without iron, both shaving the head, and both embalming the dead.

As we have no where met with any distinct notice of, or even allusion to any Peruvian machine for raising water, we insert some notices of their wells and aqueducts, &c. from Garcilasso's "Royal Commentaries of Peru." The reader can then judge whether a people who devised and constructed hydraulic works of immense magnitude for the distribution of water, were without some machines for raising it; and especially when at certain seasons they obtained it from deep wells. The inca, *Garcilasso de la Vega*, was a native of Cusco. His mother was a Peruvian princess, but his father, whose name he bore, was one of the Spanish conquerors. He was born (he informs us) eight years after the Spaniards became masters of the country, i. e. in the year 1539, and was educated by his mother and her relations, in the Indian manner, till he was 20 years old. In 1560 he was sent to Spain, where he wrote his commentaries. These were translated into English by Sir Paul Ricaut, and published in one volume, folio, London, 1688. There is reason to believe, that Peru, Chili, and other parts of the southern continent, were inhabited by a refined, or partially refined people, centuries before the time of Manco Capac, the first inca, and that a long period of barbarism had intervened, induced, perhaps, by revolutions similar to those which in the old world swept all the once celebrated nations of antiquity into oblivion. The ancient Peruvians had a tradition respecting the arrival of giants, who located themselves on the coast, and who dug wells of immense depths *through the solid rock*; which wells, as well as cisterns, still remain.

When Mayta Capac, the fourth inca, reduced the province of Tiahuanacu, he found colossal pyramids, and other structures with gigantic statues, of whose authors or uses, says Garcilasso, "no man can conjecture." The ruins of these are still extant in one of the districts of Buenos Ayres. In the same province, the writer just named mentions a monolithic temple, which, from the description, equals any of those of Egypt. These ancient buildings were supposed by the Peruvians to have furnished models for the temple, palace, and fortress at Cusco, which the first incas erected.

Acosta, in examining some of these buildings in Tiahuanacu, was at a loss to comprehend how they were erected; so large, well cut, and closely jointed were the stones. "I measured one myself (he observes) which was 30ft. in length, 18ft. in breadth, and 6ft. in thickness;" and in the fortress of Cusco were stones, he says, *much larger*.

But what adds to our surprise, many of these stones were taken from quarries at from 5 to 15 leagues distance from the buildings.

There is much uncertainty respecting Manco Capac;—who he was, and what country he came, are equally unknown. According to their *Quippus* or historical records, and the opinion of the inca, who was uncle to Garcilasso, and who communicated to the latter all the knowledge of their ancestors then extant, he made his appearance in Peru about 400 years before the invasion of the Spaniards. It is said he was whiter than the natives, and was clothed in flowing garments. Awed by his presence, they received him as a divinity, became subject to his laws, and practised the arts he introduced. He founded Cusco, and extended his influence to all the nations around. He taught them agriculture, and many useful arts, especially that of irrigating land. His son succeeded him, and,

without violence, greatly extended the limits of the kingdom, prevailing with the natives, it is said, by a peaceable and gentle manner, "to plough and manure, and cultivate the soil." His successors pursued the same mode, and with the same success.

The fifth inca, we are informed, constructed aqueducts, bridges, and roads in all the countries he subdued. When the sixth inca acquired a new province, he ordered the lands to be "dressed and manured;" the fens to be drained—"for in that art [draining] they were excellent, as is apparent by their works, which remain to this day; and also they were then very ingenious in making aqueducts for carrying water into dry and scorched lands, such as the greater part of that country is; they always made contrivances and inventions to bring their water. These aqueducts, though they were ruined after the Spaniards came in, yet several relics and monuments of them remain unto this day."

The seventh inca, *Viracocha*, constructed some water-works which, in their beneficial effects, perhaps equalled any undertakings in any other part of the world. "He made an aqueduct 12ft. in depth and 120 leagues in length; the source or head of it arose from certain springs upon the top of a high mountain between Parcu and Picuy, which was so plentiful, that at the very head of the fountains they seemed to be rivers. This current of water had its course through all the country of Rucanas, and served to water the pasturage of those uninhabited lands, which are about 18 leagues in breadth, watering almost the whole of the country of Peru."

"There is another aqueduct much like this which transfers the whole province of *Cantinsga*, running about 150 leagues from south to north. Its head or original is from the top of high mountains, the which waters falling into the plains of Queshuas, greatly refresh their pastures when the heats of the summer and autumn have dried up the moisture of the earth. There are many streams of like nature which run through divers parts of the empire, which being conveyed by aqueducts, at the charge and expense of the Incas, are works of grandeur and ostentation, and which recommended the magnificence of the Incas to all posterity, for the aqueducts may well be compared to the miraculous fabrics which have been the works of mighty princes, who have left their prodigious monuments of ostentation to be admired by future ages, for indeed we ought to consider that these waters had their source and beginning from vast high mountains, and were carried over craggy rocks and inaccessible passages; and to make these ways plain, they had no help of instruments forged of iron or steel, such as pickaxes or sledges, but served themselves only with one stone to break another. Nor were they acquainted with the invention of arches to convey the water on the level from one precipice to another, but traced round the mountain until they found ways and passages at the same height and level with the heights of the springs.

"The cisterns or conservatories which they made for these waters at the top of the mountain were about twelve feet deep; the passage was broken through the rocks and channels made of hewn stone, of about two yards long and one high, which were cemented together, and rammed in with earth, so hard, that no water could pass between, to weaken or vent itself by the holes of the channel.

"The current of water which passes through all the division Cuntisuyu I have seen in the province of Quechua, which is part of that division, and considered it extraordinary, and, indeed, surpassing the description and report which have been made of it. But the Spaniards, who were aliens and strangers, little regarded the convenience of these works, either to serve themselves in the use of them, or keep them in repair, nor yet to take so much notice of them as to mention them in their histories, but rather, out of a scornful and disdainful humour, have suffered them to run into ruin beyond all recovery. The same fate has befallen the aqueducts which the Indians made for watering their corn fields, of which two-thirds at least are wholly destroyed, and none are kept in repair, unless some few, which are so useful, that without them they cannot sustain themselves with bread, nor with the necessary provisions of life. All these works are not totally destroyed, but that there still remains some ruins and appearances of them. The last who was independent, and by far the worst of the Incas, was Atadapa, or Alabalina, the 13th from Manco Capac. He treacherously slew his brother, and murdered nearly all his relations. Garcilasso's mother and a few others escaped. He was strangled by Pizarro in May, 1533, after having purchased his life of that monster, by filling the room of his prison with gold and silver vessels and ingots, to a line chalked round the wall, at the height of about seven feet from the ground. This room was 25 feet by 16. That the Peruvians had wells in the remotest times has already been noticed, and when the Spaniards invaded their country, a great quantity of treasure was thrown into them. The discovery of these wells may yet bring to view numerous specimens of their works in the metals. We have not yet met any intimation of their manner of raising water—whether by a single cord and vessel, by means of a pulley or a windlass, or any other machine. It is true that Garcilasso, when describing the various pendants which

they wore in their ears, mentions rings as large "as the frame of a pulley, for they were made in the form of those with which we draw up pitchers from a well, and of that compass, that in case it were beaten straight, it would be a quarter of a yard long, and a finger in thickness;" but in this passage we understand him to refer to the Spanish method of drawing water; and this is probable, for in another part of his work, when speaking of the large stones used in the public buildings at Cusco, he said the workmen had neither cranes nor pulleys. Still it is possible that he referred to the mode his countrymen employed. There are conclusive proofs, however, in some extracts, that are too interesting to be omitted, that the ancient Peruvians were well acquainted with the management and distribution of water through pipes, and making and laying the latter, and, what is singular, both the sources of the water and the direction of the tubes underground were both kept secret, as was the custom with some people of Asia.

"In many of the houses (of the Incas) were great cisterns of gold, in which they bathed themselves, with cocks and pipes of the same metal, for the conveyance of water."

Some interesting particulars are also given by Garcilasso respecting the supply of Cusco with water. Speaking of a certain street, he says—"Near thereunto are pipes of excellent water, which pass underground, but by whom they were laid and brought thither is unknown, for want of writings and records to transmit the memory of them to posterity. Those pipes of water are called *silver snakes*, because the whiteness of the water resembled silver, and the windings or the meanders of the pipes were like the coils and turnings of serpents."

In the fortress of Cusco was a fountain of excellent water, which was brought at a far distance underground, but where and from whence the Indians do not know, for such secrets as these were always reserved for common knowledge in the breasts of the Inca and his council.

The Lake *Chinchin*, near Cusco, contained good water, and "by the magnificence of the Inca, was furnished with several pipes and aqueducts" to convey water into lower grounds, which were used, till rendered useless by neglect of the Spaniards. "Afterwards, in the years 1555-6, they were repaired by my lord and father Garcilasso de la Vega, he being the mayor of that city, and in that condition I left them."

In describing the temple and gardens at Cusco, he observes—"There were five fountains of water, which ran from divers places through pipes of gold. The cisterns were some of stone, and others of gold and silver, in which they washed their sacrifices as the solemnity of the festival appointed. In my time there was but one of these fountains remaining, which served the garden of a convent with water, and others were lost, either for the want of drawing or cleaning, and this is very probable, because, to my knowledge, that which belonged to the convent was lost for six or seven months, for want of which water the whole garden was dried up and withered, to the great lamentation of the convent and the whole city, nor could any Indian understand how that water came to fail, or to what place it had taken its course. At length they came to find that on the west side of the convent the water had taken its course underground, and fell into the brook which passes into the city, which, in the times of the Incas, had its banks kept up with stones, and the bottom well paved, that the earth might not fall in, the which work was continued through the whole city, and for a quarter of a league without, which now, by the carelessness and sloth of the Spaniards, is broken, and the pavement displaced; for though the spring yields not water very plentifully, yet sometimes it rises on a sudden, and makes such an incredible inundation, that the force of the current has disordered the channel and the bottoms."

In the year 1558 there happened a great eruption of water from this fountain, which broke the main pipe and the channel, so that the fury of the torrent took another course, and left the garden dry; and now, by that abundance of rubbish and sillage which comes from the city, the channel is filled up, and not so much as any mark or signal of it remains. The friars, though at length they used all the diligence imaginable, yet they could not find the ancient channel, and to trace it from the fountain head by way of the pipes it was an immense work, for they were to dig through houses and deep conveyances underground to come to it, for the head of the spring was high. Nor could any Indian be found that could give any direction herein, which discouraged them in their work, and in the recovery of the others which anciently belonged to the temples. Hence we may observe the ignorance and inadvertence of those Indians, and how little the benefit of tradition prevailed among them, for though it be only 42 years at this day since these waters forsook their course, yet neither the loss of so necessary provision as water, which was the refreshment of their souls, nor of that stream which supplied the Temple of the Sun, their god, could by nature or religion conserve in them the memory of so remarkable a particular. The truth is, that it is probable that the master workmen of those water-works did communicate or make known to the priests only the secret conveyances of these waters, esteeming

everything which belonged to the honour and service of the temple to be sacred, that it was not to be revealed to commoners, and for this reason, perhaps, the knowledge of those waters might die, and end with the order of priests. "At the end of six or seven months after it was lost, it happened that some Indian boys were playing about the stream, discovered an eruption of water from the *broken pipe*, of which they acquainted one the other; at length it came to the knowledge of the Spaniards, who judging it to be the water of the convent that had been lost and diverted from its former course, gave information thereof unto the friars, who joyfully received the good news, and immediately laboured to bring it again into direct conveyance, and conduct it to their garden.

IMPROVED METHOD OF MEASURING AREAS.

THE principle of ascertaining the areas of maps by means of a moveable frame of parallel lines, and a slide moving upon or by the side of a graduated scale,* is applicable to the determination of all kinds of areas, and would be found extremely useful to geographers and others, who may require to make calculations founded upon the comparative surfaces of land and water in the globe, the areas of continents, states, provinces, or of any geographical or geological divisions on the surface of the earth. The expedient first proposed by Dr. Halley, for ascertaining the comparative areas of land and water in the earth, by cutting them out of a map, and weighing them, is certainly ingenious, but at the same time is far from being correct. Any person may at once prove this, by weighing two equal surfaces of what appears to be the most homogeneous kind of paper in a delicate balance, when he will immediately find so great a difference in their weights, as to render the method quite inapplicable where great accuracy is required. It is said that Dr. Halley ascertained the relative area of the English counties by weighing their surfaces in this manner. Dr. Long, in 1742, applied the same principle for ascertaining the relative surface of land and water in the earth; and Professor Rigaud, of Cambridge, followed his example, taking immense pains to cut out the surfaces accurately from the gores of Addison's 3-feet globes, and weighing them in a balance which easily indicated one-tenth of a grain. There is little probability that any degree of accuracy was obtained by this method, notwithstanding all the trouble it must have occasioned. But the principle of ascertaining areas, which we have before referred to, is remarkably adapted for even the most tortuous and irregular boundaries, because the parallel lines can be drawn at any fixed distance apart, according to the size of the scale, and according to the degree of accuracy required. For geographical purposes, when the scale of the map is not less than $\frac{1}{10}$ of an inch to a mile, it would probably be convenient to rule the parallel lines that distance from each other which represents a mile by the scale, and to divide the scale of the instrument to read off the areas decimally, in tens or hundreds of miles.

When the scale of a map is very large, as a third of an inch or more to a mile, it will be quite possible to determine the areas to a less quantity than one square mile, taking care always, if the map be printed either from stone or from engraved plates, or copper, steel, or wood, to reduce your area to the scale printed on the map, otherwise the contraction of the paper will occasion such serious differences as to vitiate the whole of the operations.

AGRICULTURAL ENGINEERING.

CONSIDERING that the establishment of agricultural societies and museums will be found of great importance for effecting direct improvement of land, and for introducing agricultural engineering on an extensive scale, we notice with much pleasure the proceedings of an association formed at Cork, for establishing an agricultural museum in that city. A few months ago, the Association, wishing to gain as much information as possible relating to similar institutions, and their results in England, requested a gentleman eminently qualified to form correct opinions on the subject, to visit the various agricultural museums in England, and to acquire such information as would assist the managing Committee in establishing one at Cork. The gentleman to whom this task was confided, is Sir Thomas Deane, of Dundanion Castle, a distinguished architect, well known all over Ireland, and celebrated no less for an ardent devotion to his country, than for the extent and variety of his scientific and practical attainments. Sir Thomas Deane's report was presented at a meeting held at Cork, in the beginning of the present month. The Marquess of Downshire presided on this occasion, and the meeting was attended by a great number of farmers and influential landed proprietors. A great deal of satisfaction was expressed at the valuable information collected by Sir Thomas Deane,

* See a very ample description and drawings of the instrument in the Journal for 1841.

and we understand that subscriptions for erecting the necessary buildings connected with the museum, are proceeding most favourably. It is in contemplation to collect in the museum specimens of soils, earth, manures, rocks, building-stones, minerals, grasses, &c., with specimens of all improved implements of husbandry. Where prizes are given for any improvement or invention in agricultural implements, it will always be stipulated that not a model, as in the Society of Arts, but one of the actual implements shall be deposited in the museum, so that farmers and others may at all times have access to it, and be able to avail themselves of its advantages. The report also speaks in high terms of the practice adopted by the Royal Agricultural Society of England, of giving premiums for the best specimens of corn, and it is probable that this example will be followed by the association now established in Cork.

ELECTRICAL EXPERIMENT.

A paragraph under this head appears in a recent number of the *Spectator*. It seems to be intended for a hoax, or a joke of some kind, although we are quite at a loss to discover where its point lies:

"In the course of experiments instituted by Messrs. Wright & Bain, for the improvement of their electrical telegraph," says the *Spectator*, "they discovered that the electric circuit of a galvanic battery is as effectually completed through a large body of water as through an insulated wire." "We understand," continues our contemporary, "that they are now in treaty with the Government to construct a telegraph on this principle between the Admiralty and Portsmouth. One insulated wire would be laid down between the two points, to connect the galvanic battery of the outport with the printing apparatus of the Admiralty; and the return current would be sent through the earth, in lieu of using a second wire to complete the circuit. Should the moisture in the ground not prove sufficient to conduct the electricity, the inventors propose to transmit the return-current by water; making it pass down the Thames to the German Ocean, and thence along the channel to Portsmouth; this roundabout voyage to be performed instantaneously."

Verily, the *Spectator* must have been very ill off for news, when such rubbish as this was admitted to its columns.

LONDON ELECTRICAL SOCIETY.

TUESDAY, NOV. 15th.—Some specimens of Acari were laid before the Society, presented by Mr. Weekes, and obtained by him from electric action on a solution of ferro-cyanuret of potass. The following three communications were from W. G. Lettsom, Esq., M.E.S.:—"Notice of a new and important application of galvanism," by Prof. Jacobi. This alludes to having extracted gold and silver from their ores by galvanic action; the process is not described. The gold is obtained in malleable plates; the silver in aggregation. "On the employment of Electro-magnetism to the movement of machinery." The German diet had some years ago promised 100,000 florins to a Mr. Wagner, should he succeed in this matter; he now reports to the Frankfort assembly, that he has at length overcome all difficulties. "M. Pecllet's new condenser." This instrument consists of three discs of glass, coated with gold leaf, and so applied that one or other can be removed as occasion demands: its delicacy is extreme; by its aid the electrical order of metals is shown to be zinc, lead, tin, bismuth, antimony, iron, silver, platina, gold. A paper was then read "On the Polarity of the Voltaic Battery," by Mr. Gossiot. The author alludes to the fact that the polarity of the water-battery has been expressed in terms at variance with our preconceived ideas of voltaic arrangements: in his first experiments, he was almost induced to esteem that end vitreous, which in other batteries is regarded resinous, and *vice versa*, but on closer investigation, he discovered that the irregularity is due to the method of applying the test. He found converse results when he applied an exciter rod *above* or *beside* the electro-troscope; and by some diagrams, illustrative of his enquiries, that the results in the latter case are fictitious: he then shows that the true condition of the battery is as it has been long esteemed. He in conclusion objects to adding, without absolute necessity, the non-electrical nomenclature, and stated, that so long as positive and negative, vitreous and resinous, are applied to the machine, they are admissible to the battery. The secretary then concluded his translation of M. Becquerel's paper, "On the Electro-chemical properties of Gold," in which the modes of extracting one from many metals in solution are explained by exciting a diaphragm pair with the mixed solution. Electro-gilding is explained. Mr. Weekes's Register for October was then laid on the table.

RAILWAY INTELLIGENCE.

NEWCASTLE AND DARLINGTON JUNCTION RAILWAY.—Contracts are advertised to be let for the execution of that part of the line which extends from Rainton to Shincliffe, and the branch to Durham, making altogether a distance of about eight miles, and including the construction of three timber viaducts over the Shincliffe, Sherburn, and Carsop Becks.

THE ATMOSPHERIC RAILWAY.—Mr. Vignoles is a staunch advocate for the application of the pneumatic principle to railways. In a lecture recently delivered before the Royal Cornwall Polytechnic Society, with particular reference to the projected railway between Falmouth and Exeter, the Professor pledges his professional reputation and experience as an engineer, that the sum of from £10,000 to £12,000 a mile would make an atmospheric railway in any part of the country between those two places; and he was quite sure a good locomotive line could not be laid for double the money. Mr. Vignoles estimates the cost of the pipes at about £2000 per mile; the valves and apparatus for fitting, about £1000; engines and air-pumps at three-mile stations, about £600 or £700 per mile; the traveller, piston, &c., £150 per mile.

LONDON AND BRIGHTON RAILWAY.—A new deposit of plans for the branch from Crawley to Horsham will be made in the present month, and it is expected that an Act for this branch will be obtained in the ensuing session of Parliament. The Directors of this line have it in contemplation to construct a line of their own from Croydon to Vauxhall, in order that their traffic may be independent of the Croydon and Greenwich railways.

EASTERN COUNTIES RAILWAY.—In his Report of the 16th August, Mr. Braithwaite, the engineer of this line, anticipated the completion of the works as far as Colchester by about the 27th of October. In his Report, however, of the latter date, he regrets that, owing to bad weather, want of co-operation on the part of the contractors, and a serious slip at the Coln embankment, he has been prevented from fulfilling the intentions he expressed in August. Great exertions have been made in carrying on the earthwork of this line, and Mr. Braithwaite states, in his Report, that, in one week 13,570 cube yards of stuff were carried into the Coln embankment over one tip.

BURY'S FOUR-WHEELED ENGINES.—Mr. Creed, secretary of the London and Birmingham Railway, in a recent letter to the Board of Trade, announcing that a first-class carriage had been thrown off the rails by the body of a bull, which had been struck down and passed over by the engine and tender, states that this is the fourth instance where the four-wheeled engines of that line have passed over the bodies of heavy cattle without being displaced.

RAILWAY POLITICS.—The enlightened editor of a country newspaper, the *Northampton Herald*, speaking of a proposed branch of the London and Birmingham Railway, observes, in a spirit of exalted wisdom, "That if he could by the sweep of his pen do away with railways altogether, and for ever prevent their future construction, he should have no hesitation in doing so." Wise young man! What would he say to the restoration of saddle-bags and pack-horses? Will he not go a step further, and in the same spirit of magnanimous liberality denounce canals and turnpike-roads, and with another sweep of his pen call back the unformed tracks and pack-horses, and the five-miles-an-hour stage-coaches of our ancestors? The editor of the *Northampton Herald* is certainly an ornament of the age, and great reason have his townsmen to be proud of such a genius.

RAILWAYS IN FRANCE.—It appears that the French government, after many years of delay, and after many abortive negotiations with Mr. Cockerill, M. Rothschild, and others, have at length roused themselves to the necessity of meeting the demands which every where exist for a more rapid communication between the ports and the capital of the country. The immense energy displayed by their neighbours, the Belgians, in securing for themselves the full benefit of railway communication, has contributed not a little to this sudden disposition on the part of the French government.

Understanding from the recent proposals of the minister of public works in the Chamber of Deputies that the government is now disposed to entertain fair and equitable terms on the part of any capitalists who will come forward to construct lines, as a part of a very extensive system, which has been already surveyed by M. Vallée, under the directions of government, the South-Eastern Railway Company have deputed Mr. Robert Stephenson to examine the lines of railway which are projected for connecting the various towns lying to the north of the French capital, and at the same time for combining an eligible route to communicate on the one hand with Brussels, and with London on the other.

Mr. Stephenson's report is a very able and elaborate document, and the French government will derive much valuable assistance from the great experience which he brings to bear upon their project for a national system of railways. We shall allude to this report again when the measures consequent upon it are in a more advanced state.

INSTITUTION OF CIVIL ENGINEERS.

TELFORD AND WALKER PREMIUMS, 1842.

THE Council of the Institutions of Civil Engineers have awarded the following Telford and Walker premiums:—

A Telford medal in silver, and a premium of books, suitably bound and inscribed, to Robert Thomas Atkinson, M. Inst. C. E., for his paper "on the sinking and tubbing or coffering of pits, as practised in the coal districts of the north of England."

A Telford medal in silver to William Cotton, for his "memoir of Captain Huddart."

A Telford medal in silver to the Chevalier Frederick Willem Conrad, for his "history of the canal of Katwyk (Holland), with an account of the principal works upon it."

A Telford medal in silver to James John Wilkinson, for his "historical account of the various kinds of sheathing for vessels."

A Telford premium of books, suitably bound and inscribed, to Thomas Casebourne, M. Inst. C. E., for his "description and drawings of part of the works of the Ulster Canal."

A Telford premium of books, suitably bound and inscribed, to Thomas Girdwood Hardie, Assoc. Inst. C. E., for his "description and drawings of an iron work in South Wales."

A Walker premium of books, suitably bound and inscribed, to Charles Nixon, Assoc. Inst. C. E., for his "description and drawings of part of the tunnels on the Great Western Railway."

A Walker premium of books, suitably bound and inscribed, to Alexander James Adie, for his "description and drawings of the bridges on the Bolton and Preston Railway."

A Walker premium of books, suitably bound and inscribed, to John Brannis Birch, Grad. Inst. C. E. for his "description and drawings of the bridge of Kingston-on-Thames."

A Walker premium of books, suitably bound and inscribed, to Robert Richardson, Grad. Inst. C. E., for his "description and drawings of part of the works of the London Docks."

A Walker premium of books, suitably bound and inscribed, to James Combe, Assoc. Inst. C. E., for his "description and drawings of Messrs. Marshall's new flax mill, at Leeds."

A Walker premium of books, suitably bound and inscribed, to Charles Denroche, Grad. Inst. C. E., for his "description and drawings of the apparatus used for compressing gas, for the purposes of illumination, &c."

A Walker premium of books, suitably bound and inscribed, to Adrian Stephens, for his "description of the explosion of a steam boiler at the Penydarren Iron Works, South Wales."

A Walker premium of books, suitably bound and inscribed, to George Ellis, Grad. Inst. C. E., for the drawings illustrating the "description, specification, and estimates of the Calder Viaduct, on the Wishaw and Coltness Railway; with the series of experiments on the deflection of trussed timber beams for that work, by John Macneill, M. Inst. C. E."

A Walker premium of books, suitably bound and inscribed, to Thomas Chalmers, Grad. Inst. C. E., for the drawings illustrating the "report on the sinking of two experimental brick cylinders, in an attempt to form a tunnel across the river Thames, by John Isaac Hawkins, M. I. C. E."

SESSION, 1843.

The Council invite communications on the following as well as other subjects for Telford and Walker premiums:—

1. The original cost, annual expense, and durability of timber bridges, compared with similar structures in stone, brick, or iron.

2. A description of the canal of the Helder (Holland), or of any foreign engineering works of a similar kind and importance.

3. The modes of irrigation in use in northern Italy; of drainage adopted in the lowlands of the United Kingdom; or works of a similar nature in Holland, or in other countries.

4. On any of the principal rivers in the United Kingdom (the Shannon), or of foreign countries (the Po, Italy), describing their physical characteristics, and the engineering works upon them.

5. An account of the waste or increase of the land on any part of the coast of Great Britain, the nature of the soil, the direction of the tides, currents, rivers, estuaries, &c., with the means adopted for retarding or preventing the waste of the land.

6. The various kinds of limes and cements employed in engineering works.

7. The best and most economical mode of raising large stones or rocks from the beds of rivers or harbours.

8. The conveyance of fluid in pipes, under pressure, and the circumstances which usually affect the velocity of their currents.

9. The means of rendering large supplies of water available for the purpose of extinguishing fires, and the best application of manual power to the working of fire engines.

10. The most advantageous method of employing the power of a stream of water, where the height of the fall is greater than can be applied to water wheels of the usual construction.

11. The construction of large chimneys, as affecting their draught; with examples and drawings.

12. On the ventilation of coal pits or mines, in Great Britain or in foreign countries.

13. The relative merits of granite and wood pavements and Macadamized roads, derived from actual experience.

14. The smelting and manufacture of copper.

15. The smelting and manufacture of iron, either with hot or cold blast, in Great Britain or in foreign countries.

16. The comparative advantages of iron and wood, or of both materials combined, as employed in the construction of steam vessels; with drawings and descriptions.

17. The sizes of steam vessels of all classes, whether river or sea-going, in comparison with their engine power: giving the principal dimensions of the engines and vessels, draught of water, tonnage, speed, consumption of fuel, &c.

18. The various mechanism for propelling vessels, in actual or past use.

19. The description of any meter impractical use for accurately registering the quantity of water for supplying steam boilers, or for other purposes.

20. Deductions from direct experiment of the degree of condensation which is most favourable for the working of steam engines, as regards the production of mechanical power, stating the inconveniences resulting from the use of steam at a high pressure, and showing how such inconveniences may be remedied; with simple rules for indicating the proper temperature of the discharged water.

21. The various modes adopted for moving earth in railway tunnels, cuttings, or embankments, with the cost thereof.

22. On stone blocks and timber sleepers or sills, with or without continuous bearings, for railways.

23. The results of experience as regards the consumption of power for a given effect, on railways having different widths of gauge; with the advantages or disadvantages attributable to any established width of gauge.

24. On the forging of solid axles for locomotive engines and railway carriages, which are subjected to great strain, noticing particularly whether the iron used be of a cold-short or red-short quality, the relative strength of the two qualities, and whether the size of the crystals appears to influence the cohesive strength of the metal.

25. The advantages of large and small hollow wrought-iron shafts for machinery, axles for carriages, &c., the best mode of manufacturing them, and the formulae for computing the strength.

26. Memoirs, and accounts of the works and inventions of any of the following engineers:—Sir Hugh Middleton; Arthur Woolf; Jonathan Hornblower; Richard Trevithick; and William Murdoch (of Soho).

Original papers, reports or designs of these or other eminent individuals, are peculiarly valuable for the library of the Institution.

The communications must be forwarded, on or before the 31st of May, 1843, to the house of the Institution, No. 25, Great George Street, Westminster, where copies of this paper, and any further information, may be obtained.

LIST OF PATENTS.

(SIX MONTHS FOR ENROLMENT.)

Matthew Gregson, of Toxteth Park, Liverpool, esquire, for "improvements applicable to the sawing or cutting of veneers," being a communication.—Sealed November 2.

Joseph Edwards, of Bloomsbury Square, clerk, for "an improved razor-strop, or instrument for sharpening certain cutting edges, and an improved material for covering the same, which material is also applicable to other purposes."—Sealed November 2.

Sir John Scott Lillie, of Chelsea, for "certain improvements in roads."—Sealed November 2.

Pierre Pelletan, of Bedford Square, esquire, for "improvements in the production of light."—Sealed November 2.

James Bullough, of Blackburn, overlooker, for "certain improvements in the construction of looms for weaving," being a communication.—Sealed Nov. 3.

Richard Bevan, of Liverpool, wine merchant, for "certain arrangements connected with the circulation of steam employed in pipes or tubes for producing heat, and the application of such arrangements to various purposes."—Sealed November 5.

John Rothwell, of Great Bolton, grocer, for "a certain composition and preparation to promote the ignition and combustion of coke, coal, and other combustible substances, in stoves, furnaces, and grates."—Sealed November 5.

William Coley Jones, of Vauxhall-walk, Lambeth, practical chemist, for "improvements in treating or operating upon a certain unctuous substance, in order to obtain products therefrom for the manufacture of candles, and other purposes."—Sealed November 8.

Pierre Frederick Ingold, of Buckingham Place, Hanover Square, watchmaker, for "improvements in machinery for making parts of watches and other time-keepers."—Sealed November 8.

Arthur Harvie, of Wilmington Square, gentleman, for "improvements in the process of vinous fermentation," being a communication.—Sealed November 8.

Thomas Wrigley, of Bridge Hall, Bury, Lancaster, paper manufacturer, for "certain improvements in machinery for manufacturing paper."—Sealed November 8.

John Mitchell, of Birmingham, steel pen manufacturer, for "a certain improvement in the manufacture of metallic pens, and a certain improvement in the manufacture of pen-holders."—Sealed November 8.

John Spinks, the younger, of John Street, Bedford Row, gentleman, for "an improved apparatus for giving elasticity to certain parts of railway and other carriages requiring the same."—Sealed November 8.

Henrik Zander, of North Street, Sloane Street, engineer, for "certain improvements in steam-engine boilers and furnaces, and in the methods of feeding and working the same; as also in the machinery for applying steam power to propelling purposes."—Sealed November 8.

John Barnes, of Church, Lancashire, manufacturing chemist, and John Mercer, of Oakenshaw, Lancashire, calico printer, for "certain improvements in the manufacture of articles used in printing and dyeing cotton, silk, woollen, and other fabrics."—Sealed November 10.

Charles Rowley and James Turner, of Birmingham, button manufacturers, for "improvements in the manufacture of perforated metal buttons."—Sealed November 15.

André Eustache Gratien Auguste Maurras, of Cornhill, gentleman, for "certain improvements in the process and apparatus for filtering water and other liquids," being partly a communication.—Sealed November 15.

TO CORRESPONDENTS.

Mr. Dredge's Bridge in our next number, if possible.

"D. D. Neeve." His observations are perfectly just; but it is much more easy to point out the evils he complains of, than to find a remedy for them.

"L" will see that his suggestions have been anticipated.

"A Well-wisher, &c." By all means.

Erratum in last month's Journal: p. 291, at 13th line from top, for 800,000,000 gallons, read 8,000,000.

We have received too late for comment in the present month, intelligence of the institution of an Architectural College, which held its first meeting on Advent Eve.

The college will be entitled "Freemasons of the Church," and their object is the recovery, maintenance, and furtherance of the true principles and practice of architecture.

Numerous highly respectable names of architects and others have been published as honorary professors and officers in the College.

A further notice will be given in our next number.

